

# FOOD POISONING AND FOOD HYGIENE

BY

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## PREFACE

Food hygiene is a much debated subject in these days of increased food poisoning hazards. It is belittled by some and over-emphasized or the emphasis given to irrelevant points by others.

It was with a genuine desire to bring essential facts about food poisoning and its prevention to all those at work in the kitchen of every type of establishment that this work was undertaken.

The facts are derived from the practical experience and knowledge gained by many workers in the field of public health during the past century. The method of presentation has been influenced by more recent experience gained in efforts to interest the food-handling public in a technical subject which should be so much their concern.

It was hoped that the knowledge given in this way would lead to a better understanding of the necessity for cleanliness in the preparation and service of food, so that the incidence of food poisoning might be much reduced.

This book is written, therefore, for all those who are keenly interested in their work in the kitchen or food shop, and also for those who teach the principles which govern the control of food poisoning; among whom may be included the local authority health officers, canteen supervisors, managers of food stores, and teachers in schools of catering and domestic science.

I am deeply grateful to Mr. L. Kluth, Sanitary Inspector of Wembley Public Health Department for writing Chapters XII and XIII and for designing the three drawings included in these chapters; for his help and criticisms in many ways and not the least for his kindly and persistent encouragement.

I am most grateful also to Professor Robert Cruickshank, Wright Fleming Institute of Microbiology, St. Mary's Hospital, London, for his interest and encouragement, and for his help in planning the book and for reading critically the first draft of each chapter and then finally the galley proofs.

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Mr. W. Clifford, Central Public Health Laboratory has spent much time and effort on the design and drawing of charts and diagrams which have proved invaluable for the pictorial illustration of food

poisoning outbreaks and their prevention; many of these illustrations are reproduced, and I thank Mr. Clifford also for certain photographs.

I am grateful to all those who have given their permission for the use of published material and in particular to the Director of the Public Health Laboratory Service and the Director of the Epidemiological Research Laboratory of the Public Health Laboratory Service, for all data relating to incidence of food poisoning from 1939 onwards, and to the Chief Medical Officer of the Ministry of Health for permission to use the food poisoning figures in his Annual Report for the year 1951, to the Ministry of Food for the figures of licensed and operating catering establishments from 1941 to 1951, and also for their permission together with that from Her Majesty's Stationery Office to publish the Target Code from the Catering Trade Working Party Report; to Dr. Williams Smith, The Animal Health Trust, and the *British Medical Journal* for permission to publish the figures given in Tables 7 and 8, and to Dr. Joyce Wright, St. Ann's Hospital, London, for information on the bacteriology of infants' feeds, feeding bottles and teats. I also acknowledge with thanks the help of the Central Council for Health Education who willingly granted permission for the reproduction of many photographs from their filmstrips on the "Hygiene of Food-handling"; Professor G. Knaysi, Cornell University, and his publishers, for permission to reproduce photographs of bacterial division from the book "Elements of Bacterial Cytology"; and the authors and publishers of "The Principles of Bacteriology", Topley and Wilson, for permission to reproduce two micro-photographs; Mr. H. P. Sherwood, Ministry of Agriculture and Fisheries for providing a suitable photograph of the shell-fish purification station, Conway; the British Red Cross Society for taking a new photograph of a First Aid Box; Mr. R. T. Payne for two photographs (Figs. 34 and 37); Dr. J. Sleight, Andover Public Health Department, for a photograph of an exhibition unit; the Hotels Executive of the British Transport, the Central Office of Information and the Picture Post Library for photographs, and also the many firms who have submitted photographs, charts, pamphlets and other useful material—they are listed below:

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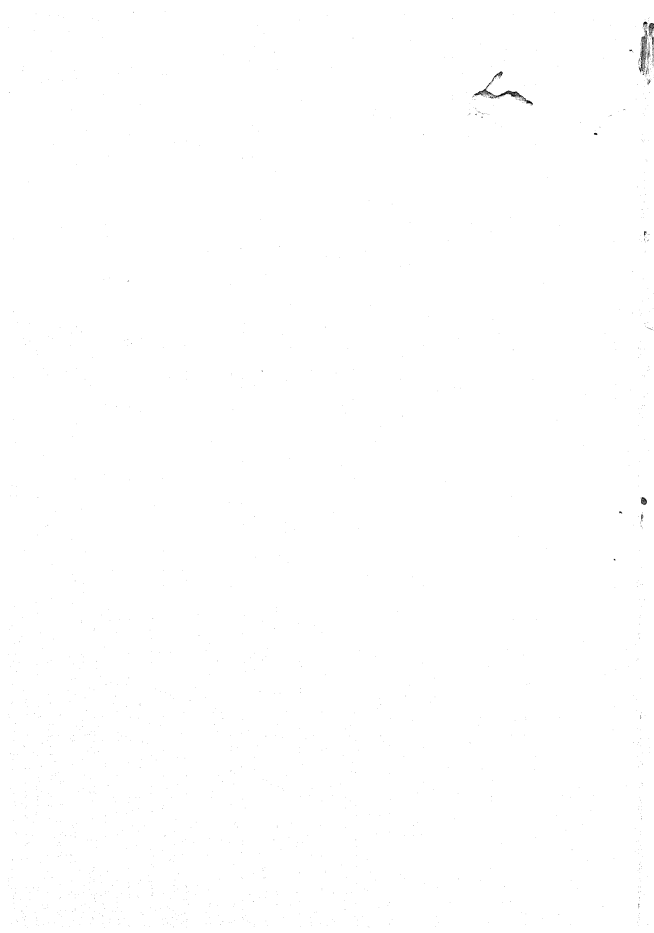
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Throughout the compilation of this work I have been thankful for the patience and perseverance of Miss Nancy Cockman.



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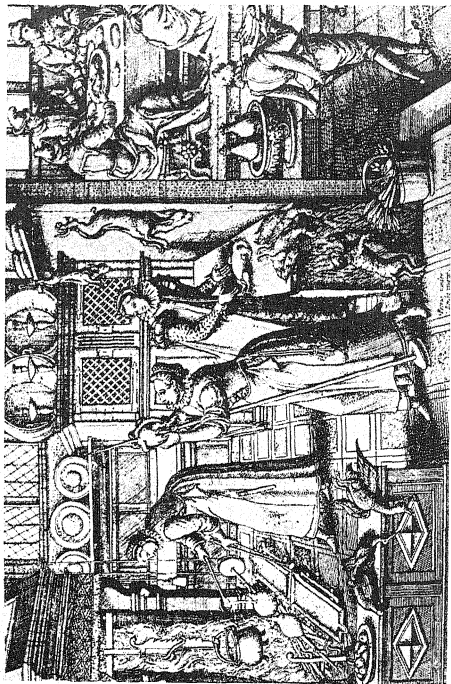


FIG. 1 Ancient Kitchen

## PART I

# *Food Poisoning and Food-borne Infection*

### CHAPTER I

## INTRODUCTION

Food hygiene is a subject of wide scope. It covers the proper handling of every variety of foodstuff and drink, and all the utensils and apparatus used in their preparation, serving and consumption.

Food should be nourishing and attractive, it must be clean and it must also be free from any noxious or harmful substances. These harmful substances may be poisonous chemicals that have entered the food accidentally during the preparation or cooking, they may be disease-producing germs introduced accidentally by workers during the preparation of the food or from animals, or they may be poisons actually produced by these germs.

This little book has been written for those engaged in food-handling with the purpose of explaining in simple language, in so far as our knowledge permits, what these various dangers are, how they arise, and how they can be prevented.

Noxious substances in food give rise to illness called food poisoning, which is usually characterized by vomiting and/or diarrhoea, and various abdominal disturbances. Food poisoning is no new disease and has been recognized throughout the ages. Centuries ago the laws of the Israelites contained detailed information on foods to be eaten and foods to be abhorred, as well as on their methods of preparation and the cleanliness of the hands of the consumers. About 2000 B.C., as recorded in the Book of Leviticus, Moses not only made many laws which protected his people against the ravages of infectious disease but laid down rules about the washing of hands after killing animals for sacrifices and before eating. Many of these laws were based on a practical knowledge of personal hygiene and the necessity for cleanliness of those suffering from certain diseases.

The accounts of food poisoning recorded in ancient history have generally been associated with chemical poisons—more especially with those deliberately introduced—but there is little doubt that this assumption was due to the fact that our knowledge of non-chemical.



that is bacterial, food poisoning dates back no farther than the latter part of the nineteenth century. Indeed the term ptomaine, i.e. alkaloid, poisoning was often used and may still be seen in the popular press to describe an outbreak of food poisoning which we know to have been caused by a disease-producing germ. The ptomaines are basic chemical substances formed by the breakdown or digestion of putrefying tissues and were previously thought to be poisons formed in tainted food.

There are some naturally occurring substances in plant life, such as Deadly Nightshade and toadstools, which can cause illness if consumed; also food may become contaminated during its preparation, with arsenic, tin, or other heavy metals, with disastrous results. The amount of food poisoning due to these natural or chemical poisons is, however, negligible and it is not intended to deal here with the subject. Nearly all our food poisoning is caused by the contamination of food by germs which grow actively in the food.

The study of germs and especially disease-producing germs is called bacteriology, from the Greek word "bactron", a rod, because the first germs observed through a microscope were tiny straight rods. Bacteria, germs, microbes, micro-organisms, or simply organisms as they are variously called—and all these names will be used interchangeably in this book—were first seen and described in 1675 by a man who was not a professional scientist. Van Leeuwenhoek was a linen draper in the town of Delft in Holland but he was also an enthusiastic maker of lenses and magnifying apparatus. It was his hobby to examine objects of nature through the lenses which he mounted together to form a primitive microscope. One day, looking through his microscope at a drop of pond water, he saw not only a number of tiny animalcules but also tiny rods, many of which moved about actively within the microscope field. He described their size as one thousand times smaller than the eye of a louse. Next he took scrapings from his own teeth, and placing them under the microscope, he saw similar objects to those he found in the water. His drawings leave no doubt that these were the first bacteria to be described, but the significance of his findings was not appreciated at the time. Indeed, it was not until Louis Pasteur, the great French chemist and bacteriologist, demonstrated the essential part that bacteria played in fermentation processes in relation to wines and beers that the scientific world was fully able to understand the significance of van Leeuwenhoek's observations made nearly two hundred years before.

Pasteur developed methods of growing bacteria so that a more intimate study of them could be made. After his work on fermentation

he turned his attention to the silkworm plague which was threatening to ruin the silk trade, then of paramount importance to France. He showed that the disease was caused by a bacterial infection of the silkworm and he was able to suggest successful measures for its control. After this he investigated diseases of animals and man, proving beyond doubt that bacteria were a necessary cause of disease. Pasteur's name will be for ever associated with the dread disease rabies and the method he devised for its prevention, but another aspect of his work is of particular importance in the study of food hygiene. He was able to show clearly and completely that the old theory of spontaneous generation, that is life arising from the inanimate, was false. In other words, if a particular food product was sterilized by proper cooking, living bacteria would not appear in that food unless they came from outside, either from the air, from the hands, or from some other infected material.

About the same time Robert Koch was also making great discoveries in Germany; he found that anthrax, tuberculosis and cholera were caused by bacteria and he devised methods to grow these germs. From this time onwards the march of discovery in the field of bacteriology was rapid. From Europe, America, Japan and other parts of the world bacteriologists were fired with enthusiasm for their new science, and soon the causative microbes of gonorrhoea, erysipelas, diphtheria, typhoid fever, dysentery, plague, gangrene, boils, tetanus and scarlet fever had been found.

After thousands of years of darkness and superstition a great light was thrown on the cause of infection, and the door was opened for a vast study of the relation of bacteria to disease in animals and plants. This study led to a knowledge of the ways in which bacterial infections spread and, as a result, methods of prevention and of cure were found. Joseph Lister applying the methods of Pasteur to surgery discovered that wounds became septic by the action of bacteria. He introduced antiseptics, disinfectants that killed bacteria, and there was an immediate and astonishing reduction in wound sepsis.

The sanitary conditions in England before 1850 were appalling. From 1840 onwards began the Great Sanitary Awakening. Edwin Chadwick belonged to a family which believed in personal cleanliness—a most unusual virtue in those days—and in 1842 he was instrumental in bringing out a Report on the Sanitary Conditions of the Labouring Population of Great Britain. The principle that environment influenced the physical and the mental well-being of the individual was introduced and, as the connection between filth and disease

was gradually realized, measures were taken to control the disposal of sewage and the purity of water supplies.

In 1854 John Snow recognized that drinking water was concerned in the spread of cholera and in the Swiss town of Lausanne an outbreak of typhoid fever in 1874 was traced to polluted water, with the result that water supplies and sewage systems were designed to eliminate this danger. The chlorination of drinking water in Britain was introduced by Alexander Houston in 1905 during a typhoid epidemic in Lincoln, and its use has helped towards the virtual abolition of water-borne disease in this country.

Towards the end of the nineteenth century the danger of infection by milk was discovered and as a result, in cities such as London, the heat-treatment of milk by pasteurization was gradually introduced; this heat-treatment kills any harmful bacteria which the milk may contain. Pasteurization is not yet universal, however, and a number of children still die yearly from tuberculous infection due to drinking raw milk from infected cows. Furthermore, we still hear of epidemics of sore throat, scarlet fever, dysentery, typhoid and paratyphoid fever from infected raw milk, particularly in country districts where much of the milk is still drunk raw. A brief description of such milk-borne and food-borne diseases is given in Chapter VII.

Acute poisoning and infection spread by food contaminated with disease-producing bacteria must have occurred from time immemorial, and it will continue to do so until we learn how to control it. Our food is not protected by the addition of preservatives in the same way as drinking-water supplies are now protected by the addition of chlorine, and we cannot insist on the compulsory heat-treatment of open-pack foods, followed by careful packing, as is used in the pasteurization and bottling of milk. To prevent the spread of infection by foodstuffs, therefore, we must either prevent bacteria from entering food or, if this is impossible, stop their growth when they have entered the food.

The first food-poisoning bacteria to be described were isolated in 1888 by Dr. Gaertner from the organs of a man who had died from food poisoning during an outbreak in Germany affecting fifty-nine other persons. Similar bacteria were found to be present in the meat which had been served to the victims, and throughout the infected carcase of the slaughtered animal from which the meat was cut. About the same time the so-called ptomaines, previously held responsible for food poisoning, were extracted from putrid foods and were found to be harmless if taken by mouth. These discoveries convinced many workers that the ptomaine theory of poisoning was wrong, and, under

the influence of Savage in this country and Jordan in the United States, food poisoning gradually came to be associated with specific bacterial contamination.

In the years 1909 to 1923 many of the bacteria now known to be responsible for food poisoning were grouped together under the generic name *Salmonella*, in honour of Dr. Salmon who discovered the first member of the group, the hog cholera bacillus, in 1885.

From 1914 onwards another group of bacteria, the staphylococci, were found to be concerned with food poisoning. When growing in food certain strains of staphylococci produce a poisonous substance or toxin which, if swallowed, gives rise to quick and violent reactions.

Gradually from year to year other bacteria have been added to the list of those proved to be responsible for food poisoning and no doubt many more will be discovered in the future. Some of these bacteria may be present in small numbers in the raw food, and owing to faulty methods of preparation, cooking or storage they are not killed, but multiply sufficiently to render the food dangerous.

In other cases, bacteria may be introduced accidentally into the food during preparation for the table after cooking, and if there are favourable conditions for growth, the rapid multiplication of the bacteria again makes the food dangerous.

Safe food means food free from dangerous bacteria; it does not necessarily mean clean food. Cleanliness implies freedom from visible dirt and mass bacterial contamination, but both of these may be present and yet the food may be safe, because it is free from those particular microbes which are disease-producing or pathogenic. The aim of food hygiene should be the production and service of food which is not only clean, but which is also free from the risk of causing disease. The problem so presented demands attention to three main factors, the personal hygiene of those responsible for handling food during production and service, the conditions under which food is stored, and the general design of kitchens and their equipment.

The incidence of food poisoning has grown from year to year, as may be seen from the following figures of recorded food-poisoning incidents (Table I). It may be asked why outbreaks of food poisoning are so common today when the average standard of living is higher than in the past, when the general and personal hygiene is much improved, and when the public's knowledge is greater. There are many answers to this question, but they are mostly related to the general change in the way of life which began soon after the turn of

the century. So insidious was the change that it was hardly noticed for several years, but in retrospect it can be dated to a period well before the First World War, when food was cheap and for the most part tastes were simple. Thousands of the working population had of necessity to take their midday meal in some sort of eating-house. The majority of these were small, rather dingy places, often with underground basement kitchens with very inadequate washing and sanitary facilities, yet it was uncommon for intestinal infection to follow meals taken in such establishments. The cost of these meals was very cheap by present-day standards, yet for the most part they were good simple meat meals, generally fresh roast or boiled joints with vegetables, often with nothing to follow. At the slightly more expensive houses there would be a fresh boiled pudding or fruit tart.

TABLE I  
*Recorded Food-poisoning Incidents*  
(England and Wales, 1939-1951)

---

<i>Year</i>												
1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951
83	47	119	73	244	291	433	685	847	804	2431	3979	3347
<i>Number of Incidents</i>												

---

Although the standard of hygiene observed in these eating-houses might be lower than the level today, the chances of food poisoning following such meals were very small, because the simple meat meal was freshly cooked and quickly served to relatively small groups of consumers.

With the changing tastes of the people came the cinema, public motor transport and the more attractive cheap restaurants. Immediately after the First World War the popularity of the large restaurant serving cheap, pre-cooked meals increased. Attractive cream-filled cakes and made-up meat dishes, on sale perhaps for days after preparation, were ideal culture media for disease-producing bacteria which may have been introduced accidentally from unclean hands; but only occasionally were outbreaks of food poisoning reported after the consumption of such meals. It was not until World War II that almost the whole nation participated in communal feeding, when in addition to the public restaurant, canteens were set up in factories, schools and offices. Although the habit of communal feeding had

been growing for years the nation was entirely unprepared for this enormous change-over. Canteen kitchens, often converted in a hurry, were of unsuitable design and inadequate for the number of meals required. Kitchens originally intended for serving a certain number of meals were forced to provide double or even treble that number, sometimes with limited equipment and inadequate staff. At the same time few of the people in charge of these catering establishments had any knowledge of the precautions necessary in preparing, cooking and serving meals on this large scale.

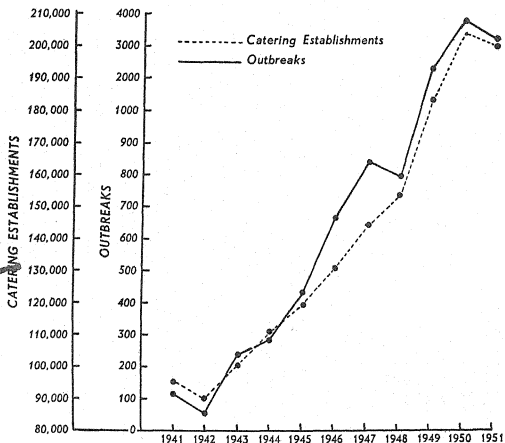


FIG. 2 Outbreaks of Bacterial Food Poisoning and number of Catering Establishments, England and Wales, 1941-1951

Under such conditions it is not surprising that errors occurred in the bulk handling of food. Large numbers of persons were served from one canteen kitchen, and a single infected dish could affect many; whereas a similar incident in a small household would affect one or two persons only.

The association between the figures for the steady rise in licensed catering establishments and the rise in food-poisoning incidents is indicated in Fig. 2.

To add to war-time and post-war problems in Britain there is the shortage of certain food and more particularly of meat. The housewife and the canteen manager can ill afford to throw anything away, and left-overs are harboured from day to day, sometimes under conditions of imperfect storage. Joints of meat are cooked the day before required because they can be sliced more economically when cold. There is also an increase in the consumption of pre-cooked foods, while made-up dishes from left-overs must be used to eke out the small rations. From these new habits there is danger of food infection.

During and after the war there were other changes in national life. We now save our scraps and put them in the pig-bin at the corner of the street. Staff shortages in many municipal departments cause a longer delay in the collection of bins than is befitting for good hygiene. The local cats and dogs knock the lids off and upset the contents, while flies enjoy the rotting food and journey between the pig-bin and the kitchen. There has been a shortage of eggs, and many people have kept their own hens and ducks at the bottom of the garden, thereby encouraging flies as well as introducing conditions suitable for rats and mice. Life has not been easy. Most people including the housewife have been working hard outside their homes, and in the general rush perhaps some of our habits of hygiene and cleanliness have been lost.

Since the war a growing number of public health bacteriological laboratories have provided increased facilities for the investigation of outbreaks. There is a greater measure of co-operation between the Medical Officer of Health, the Sanitary Inspector and the laboratory worker or bacteriologist, who are able to demonstrate to catering authorities the means by which bacteria gain access to food during the various phases of preparation, and the conditions which encourage the multiplication of bacteria to numbers able to cause disease. In 1950, for the first time, the combined recorded food-poisoning incidents from the Public Health Laboratory Service and the Ministry of Health, which receives all notifications of food poisoning from local authorities, were gathered together, so that much food poisoning hitherto ignored was brought to light.

What are the aims, therefore, for personal hygiene, food storage, and the general design of kitchens and their equipment? First, we must realize that the natural host of food-poisoning germs or bacteria is the human and animal body. Second, we must store susceptible foods at a temperature which will not allow bacteria to flourish. Third, kitchens should be designed to provide conditions for well-ordered working, with plenty of space, good ventilation and lighting,

and with equipment easily cleaned and sterilized; and fourth, these kitchens should be staffed by personnel taught the principles of hygiene in relation to themselves and the food they handle.

Before considering these things in greater detail it may be useful to describe the shape, size, habits and requirements of those minute organisms which cause disease and poison food—the bacteria.



## CHAPTER II

# ELEMENTARY BACTERIOLOGY

### The size, shape and habits of bacteria

It is difficult to understand the chain of circumstances which must precede an outbreak of disease caused by the infection of food by bacteria without knowing something about these bacteria. Furthermore, unless the habits or ways of life of microbes are known we cannot choose the weapons needed to fight them.

How can food be kept free from dangerous bacteria? If it is suspected that food is contaminated how can we prevent the germs multiplying? Furthermore, when it is known that a foodstuff may be contaminated how can we ensure that the germs are killed and their poisonous toxins destroyed before the food is eaten? All these questions can be answered from a study of the organisms that cause the trouble.

Bacteria are organisms of extremely small size and variable shape. They are minute single-celled plants placed in botanical classifications with the algae, amongst which are to be found the lowest forms of plant life, the fungi or moulds, and the lichens.

Bacteria are everywhere in the world, in soil, water, dust, and in the air we breathe. There are thousands of different types; many perform useful functions, e.g. some may turn decaying vegetable matter into useful manure, others, within the human or animal body, may assist in the development of certain vitamins essential to health. Some can be harnessed to produce drink and food for the benefit of mankind, such as in the fermentation of beer or wine and the manufacture of cheese. Others in recent years are being used to produce substances called antibiotics, of value in the cure of disease. Only a very small proportion of the total bacterial population cause disease of man and animals.

Bacteria are so minute that they cannot be seen with the naked eye and it may be impossible to tell by inspection when food is dangerously contaminated. The bacteria which cause the spoilage of food are usually harmless when taken by mouth. The dangerous bacteria are those which harm man but do not change the appearance, taste, or smell of the food.

Bacteria may be as small as  $1/1,000$  mm. and clusters of a thousand or more are only just visible to the naked eye. Thirty thousand placed side by side may measure barely an inch. Seen under the

high-powered lens of a microscope with a magnification of five hundred to a thousand times they appear in one or other of the following three forms according to the type of organism.

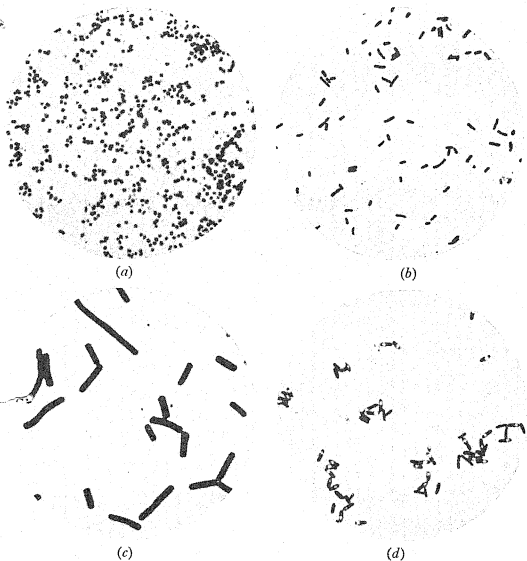
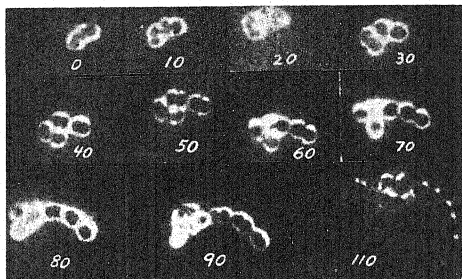


FIG. 3 Food-poisoning bacteria  
 (a) *Staphylococcus*. (b) *Salmonella*. (c) *Clostridium welchii*.  
 (d) *Clostridium botulinum*—showing spores

Round	= Coccus	for example <i>Staphylococcus</i> <i>Streptococcus</i> <i>Gonococcus</i>
Rod-shaped or cylindrical	= Bacterium or Bacillus	for example <i>Salmonella</i> <i>Diphtheria bacillus</i> <i>Bacillus anthracis</i> <i>Clostridium welchii</i>
Spiral	= Spirillum or Spirochaete	for example <i>Treponema</i> of syphilis

Some are mobile in fluids and swim about by means of hair-like processes which arise singly or in clusters from one end, both ends, or from all around the cells. Some possess capsules, outer mucinous coats which protect them against substances which might destroy them. Some can produce resting bodies called spores when conditions are unfavourable for growth, and particularly when there is a shortage of moisture. These spores form within the bacterial cell which afterwards gradually disintegrates. They can withstand high temperatures for long periods, and the processes required for the



[From Knaysi, "Elements of Bacterial Cytology,"

FIG. 4 Division or multiplication of bacteria

sterilization of canned foods are based on the time and temperature calculated to destroy these spores. Some of these sporing bacteria when allowed to multiply in foodstuffs may be responsible for ordinary spoilage, decomposing the food with the production of gas; others, such as the organism of botulism, cause food poisoning by the formation of poisonous substances in the food.

### Growth and multiplication

Bacteria multiply by simple division into two, and under suitable conditions of environment and temperature this occurs every twenty to thirty minutes. Thus one cell could become 7,000 million cells after twelve hours' continuous growth. When each cell has grown to its maximum size, a constriction appears at both sides of the centre axis, the outside membrane or envelope of the cell grows inwards and forms a division which finally splits across the cell releasing two new twin cells (Fig. 4).

### Conditions for growth and multiplication of bacteria

This subject will be dealt with very briefly here and more fully in a later chapter when susceptible foodstuffs are considered in detail.

In the laboratory a variety of media are made to suit the growth requirements of different types of bacteria. Most of them have a meat-broth base which is set solid by means of agar, a substance which is extracted from seaweed. Agar has special properties which

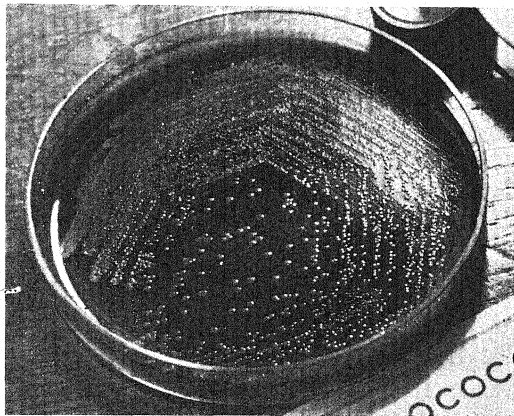


FIG. 5 Colonies of staphylococci

make it more suitable for setting bacteriological media than gelatin. It does not melt unless heated to a temperature between  $90^{\circ}$  and  $100^{\circ}\text{C}$ . ( $194^{\circ}$  and  $212^{\circ}\text{F}$ .), but once melted it does not solidify again unless cooled to about  $40^{\circ}\text{C}$ . ( $104^{\circ}\text{F}$ .). Unlike gelatin, therefore, agar can be kept at  $37^{\circ}\text{C}$ . ( $98.6^{\circ}\text{F}$ .) or even  $55^{\circ}\text{C}$ . ( $131^{\circ}\text{F}$ .) for those organisms which like to grow at these temperatures, while blood, serum or other protein matter can be added for enrichment, without fear of the protein coagulating before the agar sets.

When bacteria are spread on the surface of agar media in a Petri dish and left overnight at a suitable temperature, such as  $37^{\circ}\text{C}$ . ( $98.6^{\circ}\text{F}$ .) or blood heat, they start to grow. By division of each cell into

two every twenty minutes a small heap of bacteria consisting of many million cells is formed which is called a colony. Every kind of bacterium has a typical colonial formation; the size, shape and consistency of these colonies in particular kinds of culture media assist in bacterial identification. There is another method by which we can recognize the different types of bacteria as well as by their appearance under the microscope and on the surface of agar media, and that is by their activity in media containing different sugars. Some bacteria ferment certain sugars with the production of acid and gas, and others ferment different ones, while some ferment none at all. There are chemical tests, too, which sometimes reveal the characteristics of certain bacteria.

Many years of laboratory work have led to the development of special kinds of culture media which will enhance the growth of certain types of bacteria and depress other types. For instance, to isolate diphtheria bacilli from the throat swab of a child, the normal throat organisms can be suppressed, and the diphtheria bacilli encouraged to grow by the use of a special medium. To find food-poisoning bacteria in foodstuffs it is possible to use a medium which will suppress the harmless or non-pathogenic bacteria which may be present, and encourage the harmful or pathogenic bacteria to grow.

Bacteria will live and multiply in many foodstuffs; sometimes the type of food and the temperature of the kitchen provide conditions similar to those we use in the laboratory for cultivating bacteria. Cooked meats are good examples of such foodstuffs and so are milk and milk products such as trifles and synthetic cream, while stews and gravies resemble particularly the broths we make in the laboratory. If bacteria get into these foods in the shop or kitchen, and if they are allowed to remain in a warm atmosphere, then the organisms multiply as they would in a specially prepared medium incubated at the right temperature in the laboratory.

Most bacteria require air to live actively, but some can multiply only in the absence of oxygen; these are called anaerobes. Amongst this group are the various spoiling organisms causing botulism and some other types of food poisoning. They flourish under the conditions found at the bottom of a large container filled with stew, stewed steak, or minced meat; they would also multiply readily in canned meat and vegetables, so that great care must be taken to give adequate heat-treatment to destroy such bacteria in foods canned and bottled in the home.

All the pathogenic or harmful organisms grow best at about the

temperature of the body, which is  $37^{\circ}\text{C}$ . ( $98.6^{\circ}\text{F}$ .), although the majority will multiply between  $20^{\circ}$  and  $43^{\circ}\text{C}$ . ( $68^{\circ}$  and  $109.4^{\circ}\text{F}$ .). Extreme cold will not kill bacteria, but it will prevent them multiplying and this is the reason for the storage of susceptible foodstuffs at low temperatures. Refrigeration prevents not only the spoilage of food but the danger of proliferation of harmful bacteria. Above  $40^{\circ}\text{C}$ . ( $104^{\circ}\text{F}$ .) the growth of bacteria falls off rapidly, and in general it

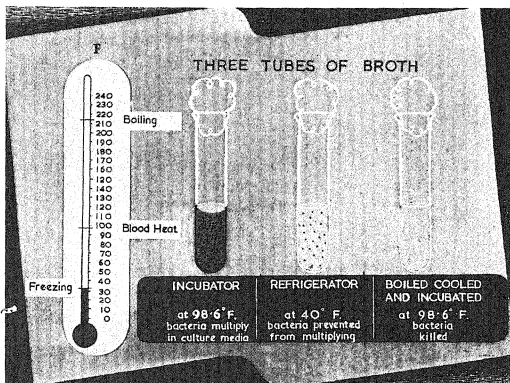


FIG. 6 The effect of temperature on bacteria

ceases above about  $45^{\circ}\text{C}$ . ( $113^{\circ}\text{F}$ .). Non-sporing bacteria are killed at temperatures above  $60^{\circ}\text{C}$ . ( $140^{\circ}\text{F}$ .) for varying periods of time. For example, to make milk safe, that is, free from harmful bacteria, it is pasteurized at  $62.8^{\circ}\text{C}$ . ( $145^{\circ}\text{F}$ .) for thirty minutes or at  $71.7^{\circ}\text{C}$ . ( $161^{\circ}\text{F}$ .) for fifteen seconds. Boiling kills living cells, with the exception of spores, in a few seconds, but spores may require to be boiled for five or more hours before they are killed. To destroy them in a shorter time, temperatures above boiling must be used.

Bacteria will not multiply if they are kept without water; there must be at least 15 per cent moisture for normal bacterial growth. Dehydration may not kill them; in fact they may survive for long periods, and revive as soon as they have sufficient moisture added to them.

We have learnt so far that bacteria are minute single-celled organisms which are ever present in the environment in vast numbers, and that most of them are harmless, although a small proportion can produce disease. We have learnt also that human beings and animals carry disease-producing bacteria, and that bacteria when allowed to invade certain foodstuffs will multiply provided the conditions of time, temperature and moisture are correct. We have learnt also that bacteria stop multiplying in the cold and will die if they are too hot. We shall go on to consider in more detail the bacteria which cause food-borne infection, particularly where they live and how they behave.

### CHAPTER III

## BACTERIAL CAUSES OF FOOD POISONING

Bacterial food poisoning may be described as an acute attack of abdominal pain and diarrhoea, usually accompanied by vomiting, developing within 2 to 36 hours of eating food. The bacterial causes may be classified under four headings, (a) salmonella infection, (b) staphylococcal toxin, (c) other organisms such as *Clostridium welchii*, streptococci, paracolon bacilli, and (d) botulism caused by the toxin of *Clostridium botulinum*.

Each of the groups of food-poisoning organisms produces in its victims characteristic clinical symptoms. The time of incubation, that is, the interval between the consumption of the contaminated food and onset of symptoms, are equally typical for the different groups. Table II summarizes the incubation period and duration of illness for the four groups of food-poisoning organisms.

It may not be possible to investigate a particular outbreak of food poisoning until some hours, days, or even weeks after the event and it is most important to record the incubation period, symptoms and duration of illness of the various patients in order to arrive at a conclusion about the cause of the outbreak. When foodstuffs and other specimens from suspected food poisoning are brought to the laboratory a knowledge of the clinical details is helpful to those examining the material.

### Salmonella infection

The salmonella group of organisms cause food poisoning by infection, that is, by invasion of the body. Usually the contamination of the food comes from human and animal excreta—in a number of ways. It is probable that illness occurs only if the organisms are ingested in large numbers, so that a chance contamination of the food by a small number of organisms may not be harmful. When these organisms are given time to multiply in the food, that is, if the food is allowed to stand for some hours in a warm room, then sufficient numbers of bacteria will develop to cause acute symptoms.

The onset of illness occurs usually within 12 to 24 hours; it is less sudden and the symptoms less acute than those produced by the toxin of staphylococci. The illness is due to growth of the organisms within the body and it is accompanied by fever, headache and a



general aching of the limbs as well as by vomiting and diarrhoea. The duration of illness is longer than that caused by the toxin of the staphylococcus and may be from one to eight days.

TABLE II  
*Bacterial Food Poisoning*  
*Incubation Period and Duration of Illness*

<i>Cause of food poisoning</i>	<i>Incubation period</i>	<i>Duration</i>
Salmonella infection	12-24 hours	1-8 days
Staphylococcal toxin	2-6 hours	6-24 hours
<i>Clostridium welchii</i> and other organisms	8-22 hours	12-24 hours
Botulism	24-72 hours	Death in 24 hours to 8 days or slow con- valescence over 6-8 months

### Staphylococcal toxin

Food poisoning caused by staphylococci is due not to a large dose of the organisms but to the ingestion of some poisonous or toxic product which is formed by them in food. It is only when there is profuse growth of these organisms outside the body, that is, when sufficient pre-formed toxin is produced in food, that poisoning occurs.

There is an incubation period from 2 to 6 hours and a rapid onset of symptoms characterized by acute vomiting followed by diarrhoea, pain, cramps, and sometimes prostration and collapse; recovery is rapid.

### Other organisms

In addition to the two most important groups of food-poisoning organisms—the staphylococci and salmonella—there is a miscellaneous group of bacterial infections and intoxications caused by the contamination of food by a number of different organisms. It is suggested that poisonous toxins may be formed by organisms not usually associated with food poisoning unless they are allowed to multiply profusely in foodstuffs. The incubation period of this group varies from 8 to 22 hours, and the duration of symptoms is short—usually

12 to 24 hours. An example of this type of food poisoning is that caused by the anaerobic sporing bacillus *Clostridium welchii*. Certain types of this organism produce spores which resist boiling for four or more hours. They may be present on raw meat and survive boiling or stewing. If the meat is allowed to remain in the kitchen and cool slowly overnight the spores will germinate into rapidly multiplying bacterial cells. The conditions in the centre of the mass of cooked stew, gravy or mince are ideal for their growth, and by morning there may be enough bacterial bodies and toxin present to produce food poisoning in many children and adults. The symptoms are mild, consisting of acute abdominal pain and diarrhoea, rarely accompanied by nausea or vomiting, and lasting about 12 hours.

Other organisms, for example, certain streptococci, may give rise to food-poisoning symptoms resembling, though less acute than, those given by the toxin of staphylococci. There are paracolon bacilli, giving symptoms similar to those caused by organisms of the salmonella group; and coliform bacilli, proteus and other organisms normally present in the intestine are often blamed for gastro-intestinal upsets from food heavily contaminated by them.

### Botulism

Botulism is usually a fatal type of food poisoning, fortunately now rare, caused by the toxin of another anaerobic spore-bearing bacillus known as *Clostridium botulinum*. The toxin, produced in food by actively multiplying organisms, is lethal in very small doses and gives rise to symptoms quite different from those of the organisms just described. The incubation period varies from 24 hours or less to 72 hours, and the first signs are lassitude, fatigue, headache and dizziness. Diarrhoea may be present at first but later the patient is obstinately constipated. The central nervous system becomes affected and there is a disturbance of vision; later, speech becomes difficult and there is paralysis of the throat muscles. The intoxication reaches its maximum within 24 hours to 8 days and death often occurs by paralysis of the respiratory centres. If, after 8 days, the patient survives, there is usually a slow convalescence extending over 6 to 8 months.

The general characteristics of the various types of food poisoning have been given and it should be emphasized that details of symptoms and incubation periods, as well as information about the foods eaten and how they were cooked, are most important for the investigation of outbreaks. Patients questioned during the course of such investigations should go on to the best of their abilities to recall the

help in the early stages it is often impossible to reach a satisfactory conclusion.

Table III shows an analysis of the notified causes of food poisoning in England and Wales during 1951.

Fifty per cent of outbreaks were due to organisms of the salmonella group, and in particular to one type of salmonella called *Salmonella typhi-murium*, 2 per cent were due to staphylococci, 0.6 per cent to *Clostridium welchii*, 0.2 per cent to other organisms, 0.1 per cent to chemicals, and in a high proportion of incidents (47 per cent) the cause was not discovered.

TABLE III  
*Presumed Causes of Food Poisoning in 1951*  
(England and Wales)

<i>Presumed cause</i>	<i>Incidents</i>	
	<i>Number</i>	<i>Per cent</i>
Salmonella		
<i>Salm. typhi-murium</i>	1216	36.3
Other salmonella	452	13.5
Staphylococci	65	1.9
<i>Clostridium welchii</i>	20	0.6
Other organisms	5	0.2
Chemical	2	0.1
Unknown	1587	47.4
Total	3347	100.0

Table IV shows the division of these food-poisoning incidents into three categories as follows:

- Outbreaks* which involve two or more related cases in persons of different families.
- Family outbreaks* which involve two or more related cases in persons of the same family.
- Sporadic cases* which refer to odd cases unrelated to any other.

Of the incidents due to salmonella infection 82 per cent were sporadic cases, and 18 per cent were outbreaks affecting several individuals; whereas of incidents due to staphylococcal toxin, 3 per cent only were sporadic cases and 97 per cent were outbreaks. Thus

the actual number of cases occurring may not be very different in these two main groups, for one staphylococcal outbreak may affect many hundreds of people.

It will be convenient now to consider in some detail the reservoirs of infection and the ways by which harmful bacteria are spread.

TABLE IV

*Food Poisoning in 1951*

*Sporadic Cases, Outbreaks and Family Outbreaks by Presumed Causes*  
(England and Wales)

<i>Presumed cause</i>	<i>Sporadic cases</i>	<i>Outbreaks</i>	<i>Family outbreaks</i>	<i>Total</i>
Salmonella	1367	126	175	1668
Staphylococci	2	40	23	65
<i>Clostridium welchii</i>	—	17	3	20
Other organisms	1	4	—	5
Chemical	—	—	2	2
Unknown	1347	156	84	1587
Total	2717	343	287	3347

## HUMAN AND ANIMAL RESERVOIRS OF INFECTION AND WAYS OF SPREAD OF INFECTION

It has already been said that bacteria are everywhere in the world—in soil, water, dust and in the air that we breathe and that most of these organisms are harmless to man. As we have learned, however, there are many types of bacteria that can infect man and animals. Under certain conditions they are able to grow and multiply in the tissues of the body and bring about disease. During illness it is well known that the infecting germs can be transferred from one person to another, from animal to animal, or even from animal to man. The fresh host may succumb to the disease, or he may resist it and show no symptoms, although the infective germ is harboured within his body for a variable period of time. In this way those germs which are adapted to live under the conditions provided by the human or animal body maintain their existence and, when they are not actively causing disease, they may be spending a quiet time in the nose, throat, or bowel of a healthy person or carrier.

When it was first realized, early in the twentieth century, that bacteria were capable of causing food poisoning and food-borne disease, it was thought that animals were invariably the natural reservoir of the family of intestinal organisms which is responsible for the majority of food-poisoning cases. The first discoveries had led investigators to diseased animals as a source of the meat eaten by those affected. Subsequent workers, however, showed that the human body often harboured organisms of the salmonella group as well as other food-poisoning bacteria.

Information has since accumulated on the habits of bacteria, in or on their human hosts and the methods of transfer from the human reservoir to foodstuffs, and it is now generally agreed that man is the most important immediate source of outbreaks of food poisoning.

**The human reservoir**

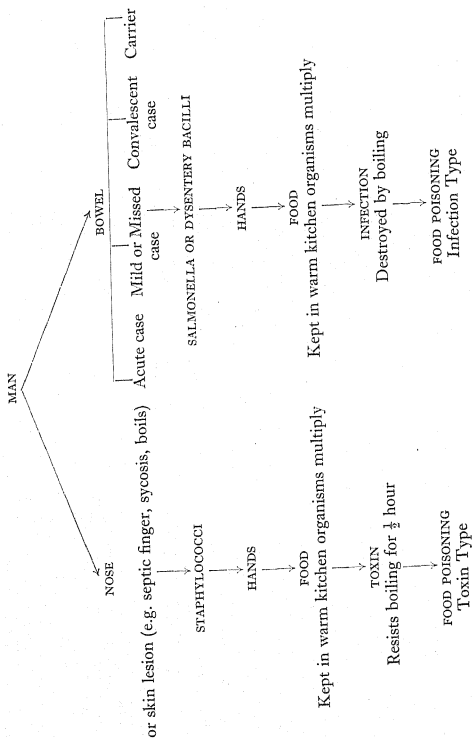
Table V shows the reservoirs and possible paths by which infection is spread from man to food for the two main food-poisoning groups of organisms.

**The nose, hand, and skin lesion.** Considering the left-hand side of the table first, we know that 50 to 60 per cent of normal people

carry staphylococci in the nose. There are many different types of staphylococci some of which are harmless. Nevertheless, certain types, if transferred to food and allowed to grow, can produce the poisonous toxin responsible for acute illness. A surprisingly high proportion of people who carry staphylococci in the nose carry the same staphylococci on their hands; in fact observations indicate that 15 to 20 per cent of such people do so. Many of us unconsciously touch the nose and most of us at one time or another have to use a handkerchief; nasal secretions are laden with bacteria, some of which may be staphylococci, and they are almost certain to contaminate the hands. Sometimes this carrier state is only transitory, and the organisms are soon lost by washing or are kept in check by the acid reaction of the skin. Sometimes, however, they penetrate into the deeper layers of the skin, into the pores and hair follicles where they may live and multiply. Hands infected in this way may be washed and scrubbed and yet continue to harbour these organisms in spite of all precautions. In the hot steamy atmosphere of the kitchen the pores are well opened and the organisms rise to the surface of the skin in the perspiration. There are ways in which we can try to rid the hands of staphylococci such as by antiseptics or ultra-violet light, but there is no certain method of success. It is better for those who harbour staphylococci in the skin of their hands to do work which does not necessitate touching susceptible foodstuffs such as meats and milk products.

As well as the normal nose and hand carriers of staphylococci there are others who are suffering from staphylococcal infections which include boils, sycosis barbae (barber's rash), and septic cuts and burns. These lesions are primarily caused by staphylococci and may contain pus heavily infected with this organism; a tiny speck of this pus could inoculate a foodstuff with thousands of germs. Staphylococci like to live in cut surfaces; they thrive in the moist conditions provided by the serous fluid which is always present. Therefore the tiniest cut or abrasion, however clean and healthy it appears to be, may harbour many food-poisoning organisms and form a focus of infection.

There are many examples of outbreaks of staphylococcal food poisoning caused by the contamination of foods by staphylococci introduced from boils, ulcers, abrasions on the hands, and even from apparently normal hands. An infected trifle which caused acute illness amongst patients in a particular hospital ward was made by a chef with a varicose ulcer of the leg. The staphylococci growing profusely in the trifle were found to be of the same type as those infecting the ulcer.

TABLE V *Human Reservoirs of Food-poisoning Organisms*

**The intestine.** The right-hand side of the table shows the human source of the salmonella food-poisoning organisms. Although animals form the ultimate reservoir of these organisms, man is frequently the immediate source of infection. In any outbreak of infectious disease those in contact react in one of the following four ways. A proportion will succumb to an acute illness; some will exhibit symptoms so mild that they may be ignored or attributed to other

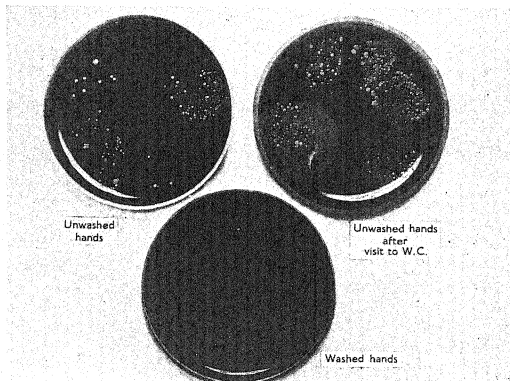


FIG. 7 Colonies of bacteria from washed and unwashed fingers

indispositions—ambulant case; some will continue to excrete the organism after recovery from illness—convalescent carrier; and others may harbour the infecting germ for a short while without exhibiting symptoms—temporary carrier or symptomless excreter. All these people may pass on the infecting germs to others.

Food-poisoning bacteria as well as dysentery, typhoid and paratyphoid bacilli are excreted from the body in the stools; they may contaminate the hands and so be transferred to food, if the hands are not washed thoroughly after visiting the toilet. Toilet paper is porous and bacteria can readily pass through to the hands.

It may be asked how long after infection do people remain carriers and continue to excrete infective organisms; this will depend on the type of organism. Typhoid and paratyphoid bacilli may be excreted



persistently in the faeces for many years, while other salmonella bacilli and dysentery bacilli are excreted usually for a few weeks only, rarely months and only exceptionally for a year or more.

**Other human reservoirs.** Other reservoirs of infection in human beings are the mouth and throat which may harbour bacteria able to cause food poisoning when transferred directly to food by coughing, sneezing, or indirectly by means of a contaminated handkerchief.

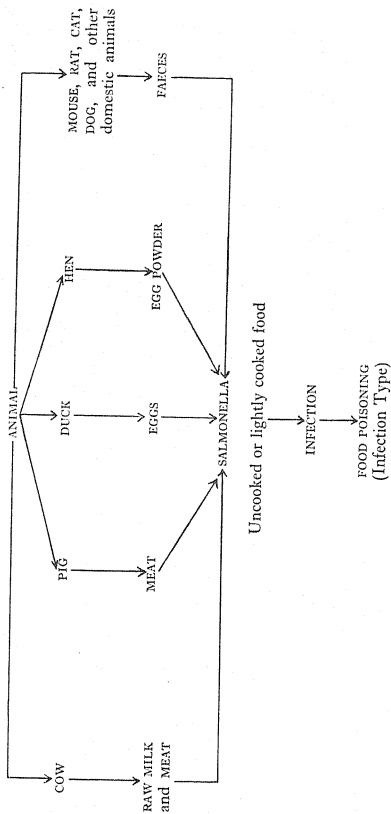
Hair does not usually harbour pathogenic bacteria, although it may do so if there are lesions of any sort on the head.

### **Animal reservoirs**

For many years animals were thought to be the source of food-poisoning bacteria and emphasis was placed on the flesh and excreta of animals as the main reservoir. Table VI indicates some of the animals which we know may be reservoirs of organisms of the salmonella group. The meat of cows, oxen, etc., may be naturally infected and, furthermore, organisms from infected carcasses may be transferred to other meat either in the slaughter-house, during transport, or in the butcher's shop. An example of the transfer of infection by this means was provided by an outbreak of food poisoning of the salmonella type which occurred in 1947. There were about 3,000 to 4,000 cases with three deaths and the origin of infection was probably an infected pig, the carcass of which contaminated other carcasses in the slaughter-house by various means, particularly by the spreading of infection from wiping-down cloths. This home-killed raw meat was distributed to butchers' shops and handled in conjunction with canned meat. The infective raw meat and the cold cooked meats were weighed on the same balance, cut with the same knife and handled with the same hands; there was, therefore, plenty of opportunity for the spread of infection. Had the infection been confined to the raw meat alone, the outbreak might not have been so widespread, because the organisms would have been destroyed by cooking. The contamination of the pressed beef and other cooked meats was responsible for the widespread nature of the outbreak, for these meats were eaten without further heat-treatment—often after storage at a temperature favourable for bacterial multiplication.

Food may be soiled also by animal excreta, for example, from cow to milk, from poultry to eggs and from vermin to all kinds of food.

It will be noticed, for instance, that all packets of dehydrated whole egg include in the printed instructions the sentence, "This egg must be used immediately after mixing".

TABLE VI *Animal Reservoirs of Food-poisoning Organisms*

During the war small outbreaks of food poisoning occurred which were due to types of salmonella not usually found in this country, and it was discovered that dried whole egg coming from the United States of America and other countries contained small numbers of salmonella of the same types. Examination of the imported packets of dried egg showed that approximately 10 per cent of them might be contaminated. The organisms were present in such small numbers that provided the powder was used immediately after rehydration and cooked well no harm resulted.

It is shown in Table VII that in a small proportion of the fowl population salmonella organisms are carried in the intestine, and it is known that the shell of a hen's egg becomes contaminated through contact with faeces in the cloaca or in the nest. When large numbers of eggs are broken into a container ready to be spray-dried, fragments of shell or specks of dirt from the shell may fall into the mixture and the temperature reached during the process of spray-drying is not high enough to kill the bacteria which may be introduced in this way.

The same danger may occur when eggs are broken on a large scale for the production of bulk liquid whole egg, and a small proportion of samples may contain salmonella organisms. This substance should, therefore, be stored frozen and used only for those foods which require thorough cooking.

Salmonella are rarely found inside a hen's egg. On the other hand, in an unknown but probably small proportion of ducks' eggs salmonella organisms may be found in the yolk. It seems that in the duck the organ responsible for the formation of the egg may become infected with salmonella. The duck is a notorious scavenger and it is possible that in the course of the day's activities, which include swimming in a pond which may be contaminated by rats, the infected material is picked up, ingested, and transferred from the digestive tract to the oviduct. Unlike the hen, which likes to keep dry, the duck frequently lays its eggs in wet and muddy places, so that the shell may be particularly susceptible to the penetration of bacteria. The drake may become infected, and spread the infection from bird to bird. Whatever the cause, however, it is accepted that ducks' eggs may be contaminated. They should, therefore, be used with caution and regarded as a possible source of danger. The infected ducks may look and behave normally, although it is said that they may stop laying for a time. Until they do so, however, eggs which look and smell normal are a potential source of danger. It is no easy task to trace the source of infection in a large flock of ducks, and it is not lightly undertaken. The public must, therefore, protect themselves

by carrying out strictly the recommendations given for the use of ducks' eggs in cooking. (See Chapter X.)

TABLE VII  
*Livestock Census—June 1950*  
and

*Isolation of Salmonella from the Faeces of Adult Healthy Domestic Animals*

Species of animal	Livestock census June 1950	Number examined	Salmonella positive	
			Number	Per cent
Turkeys	800,000	650	16	2.5
Geese	800,000	100	2	2.0
Ducks	2,200,000	500	6	1.2
Pigs	2,200,000	600	4	0.67
Chickens	61,400,000	750	5 (3)*	0.67 (0.4)*
Cattle	8,000,000	750	3	0.4
Horses	417,000	500	1	0.2
Sheep	12,400,000	500	0	0

\* *Salmonella* other than *Salm. pullorum*.

TABLE VIII  
*Livestock Census—June 1950*  
and

*Estimated Number of Adult Healthy Animals carrying Salmonella*

Species of animal	Livestock census June 1950	Estimated number positive for salmonella
Chickens	61,400,000	410,000
Cattle	8,000,000	32,000
Ducks	2,200,000	26,000
Turkeys	800,000	20,000
Geese	800,000	16,000
Pigs	2,200,000	15,000
Horses	417,000	830
Sheep	12,400,000	0

### Vermin and rat poisons

Both the mouse and the rat can suffer from an infection due to one of the types of salmonella which infect man. Naturally when they are so infected their excreta are contaminated and become a source

of danger to food which they soil. It is known that a proportion of the vermin population become intestinal carriers of salmonella, in the same way as described for human beings.

Some years ago an outbreak of food poisoning was caused by the contamination of sheet gelatin, used for making pies, by salmonella presumed to have come from the droppings of vermin. Salmonella organisms were isolated from similar sheets of gelatin and mice caught in the vicinity were found to be infected with the same organism; it was assumed that their droppings had soiled the gelatin.

Certain rat poisons rely for their lethal action on the presence in them of virulent organisms of the salmonella group; the use of such poisons is open to many dangers. The droppings from infected rats may contaminate foodstuffs while the rat is ill; the infection will pass from rat to rat, thus increasing the carrier rate of salmonella amongst the rat population; greatest of all is the danger involved in the handling of this material. Outbreaks of food poisoning have been reported in different parts of the world which have been due to the transfer of virulent organisms from rat poison to the hands, and thus to the food of families employing this particular preparation to eliminate rats and mice.

Recently investigations carried out on domestic animals showed that of the large numbers of faeces examined a proportion contained organisms of the salmonella group.

Table VII gives the proportion of adult healthy domestic animals from which salmonella were isolated from the faeces; and Table VIII gives the livestock census for these same animals in June 1950, together with the estimated number, based on the figures given in the previous table, of adult healthy animals which might reasonably be expected to be carriers of salmonella. The investigators concluded from their figures that, although the carrier rate amongst chickens was not nearly so high as that amongst turkeys, nevertheless it was probable that chickens provided the largest reservoir of infection, because of their greater numbers. The authors pointed out that symptomless faecal excretors of salmonella are of great importance to public health. Such animals during their life may infect other animals and may also contaminate milk, eggs and other food products, and, even after slaughter, carcasses may become contaminated with salmonella. More attention should be paid to hygiene during and after the slaughter of food animals, if the risks of food poisoning from animal excreta are to be reduced. It was stated that the contamination of poultry during evisceration may be of importance, particularly as this process is often carried out by those responsible for other food preparation.

Approximately 1 to 2 per cent of cats and dogs may be carriers of salmonella, and the complaints of the customer about cats walking on counters and in shop windows, and the complaints of the shop owner about customers' dogs which are allowed to roam around the shop, may be fully justified.

### Other ways in which infection spreads

Flies used to be considered a major factor in the spread of infection; no doubt they still play a part, but more importance is now attached to the direct contamination of foods by human beings and animals from the reservoirs of infection within them.

In countries where sanitation is poor and intestinal diseases such as dysentery, typhoid and paratyphoid fever are rampant, flies are a greater menace. They have ready access to infected excreta from cases and carriers, they can transfer the disease-producing bacteria to foodstuffs, and they are allowed to flourish. In the more civilized countries the fly population is dealt with drastically, and in consequence it is much smaller. With water carriage of sewage and careful disposal of waste, there are few places from which the fly can pick up infective material; this is true for towns, although it may not be so true in country areas with primitive sanitary arrangements.

A source of danger in Britain is the pig-bin, often to be seen without its lid and with the contents strewn around. Sometimes these receptacles are upset and ransacked by the local dogs and cats. From these, as well as from the untidy lidless dustbins of private houses, restaurants, hotels, canteens and other premises which prepare foodstuffs, the fly can scavenge rubbish which it may regurgitate on to foodstuffs in the kitchen; it may also carry particles of infected material on its feet from the waste bin to foods. The house fly and the stable fly as well as the larger type of bluebottle and greenbottle may transfer infection in this way. Heat-resistant *Clostridium welchii* have been isolated from many batches of greenbottle and bluebottle flies.

There are other insects, particularly the cockroach, which can also transfer food-poisoning bacteria from place to place.

An account of an outbreak of food poisoning which occurred recently in an Australian hospital describes the isolation from flies, cockroaches and mice of the salmonella organisms responsible for the infection. It is not suggested that these creatures were the original source of infection, but that they had become infected from the contaminated environment. During washing of hands and infant clothing in the sinks of the ward, contaminated wash water could be splashed on to the immediate surroundings, when cockroaches

creeping along the floor, pipes and sinks would carry the infective bacteria on their feet and bodies from one place to another.

Wasps, bees, spiders and other creatures which do not breed in refuse and manure heaps are unlikely to carry harmful bacteria, for in comparison with flies their habits are clean.

Inanimate objects such as towels, pencils, door-handles, W.C. equipment, crockery and cutlery may serve as intermediate objects in the transfer of infection from person to person, or from person to food.

Roller towels are a danger in this respect. If the hands are not washed thoroughly, dirt containing bacteria will be left on the towel to be picked up by the next person who uses it. The discharge from staphylococcal infections, for example boils, barber's rash and other septic spots present on the face, hands or arms of canteen personnel, may be left on communal towels. The spread of boils throughout a factory has been encouraged in this way. In more than one outbreak of food poisoning it has been assumed that a towel or other object was responsible for the transfer of salmonella organisms from a carrier to a food-handler.

Door-handles, pulley chains and other W.C. equipment should be constructed of material which will not permit the survival of bacteria; most metals are self-sterilizing, and they should be used in preference to wood.

Paper money is frequently blamed as a means of spreading infection, coins of copper, silver or nickel are invariably sterile when examined bacteriologically, even though well handled. Bank-notes as well as ration-books and newspapers may harbour living bacteria for a short time, and care should be taken that the fingers are not licked before handling them; the same applies to any paper wrapping.

Infective bacteria from crockery and cutlery may be transferred to those using them or to foodstuffs, although it is almost impossible to trace outbreaks of infection which have originated or spread in this manner. Recommended methods for washing crockery and cutlery will be given in a later chapter.

## THE VEHICLE OF INFECTION

The vehicle or medium of infection is the foodstuff in which bacteria responsible for food poisoning have multiplied, so that the food is no longer safe to eat. Some foods, both solid and liquid, are easily contaminated and favourable for the growth of bacteria while others are not. The dose of bacteria necessary to infect or to produce sufficient toxin to cause irritation varies with the types of organism, and the resistance of the individual who swallows them. The number of organisms in a particular foodstuff at any given time will depend on the foodstuff, its temperature, and the length of time it has been kept.

**Food and drink easily contaminated**

Table IX, compiled from figures of 373 food-poisoning incidents occurring in England and Wales during a recent year, shows the vehicles of infection, or in other words the contaminated foodstuffs which were proved responsible for these incidents.

**Meat.** In 211 of the outbreaks (57 per cent) some form of meat dish was blamed. It will be seen that the meats which caused food poisoning are classified as "canned", "processed", and "meat" (no further details available). One outbreak only was attributed to "fresh" meat. It may be assumed that if we ate freshly cooked, roasted, boiled or fried joints exclusively, cases and outbreaks of food poisoning arising from meat would be considerably reduced if not eliminated.

In large-scale catering kitchens there is a growing habit of cooking meat one day and allowing it to cool overnight in the kitchen in readiness to be served cold, warmed-up, or in the form of a pie or pasty the next day. This is dangerous for two reasons. First, in boiled meats, bacterial spores may survive the heat-treatment and germinate overnight at room temperature into actively multiplying bacterial cells which may cause food poisoning. Second, the roast or boiled joint carved cold may be contaminated during slicing or other manipulation carried out with the help of the fingers.

Furthermore, present shortages, particularly of fresh meat, have forced us to make up our diet with many different types of processed



meatstuffs, which were responsible for 144 of the 211 outbreaks suspected to have been caused by meat. There is ample opportunity for contamination either during the preparation of these packs or during their sojourn in the retail shop and consumer's kitchen. If they leave the factory already contaminated with bacteria, multiplication may take place during transport, and there will be further contamination during the handling of these products in the shop and

TABLE IX  
*Food Poisoning, 1951*  
*Vehicles of Infection*  
(England and Wales)

<i>Vehicle</i>	<i>Incidents</i>	
	<i>Number</i>	<i>Per cent</i>
MEAT		
Processed and made-up	144	38.6
Canned	44	11.8
"Meat"	20	5.4
Fresh	1	0.3
Soup, gravy and stock	2	0.5
	211	56.6
SWEETS		
Trifles, custards, cream buns, ice-cream and other sweet dishes	48	12.9
FISH		
Canned	21	5.6
"Fish"	11	2.9
Shell-fish	7	1.9
Processed	2	0.5
	41	10.9
EGGS		
Duck	29	7.8
Hen	3	0.8
"Eggs"	7	1.9
	39	10.5
Milk and Cheese	10	2.7
Fruit and vegetables	21	5.6
Miscellaneous	3	0.8
Total	373	100.0

home, from the hands, utensils, bench and balance. Most of these made-up meatstuffs are eaten cold or at best merely warmed-up, and there is, therefore, no likelihood that the contaminating organisms or their toxins will be killed by heat before the meat is consumed. Of food-poisoning incidents traced to the consumption of processed or made-up meat there were 90 during the years 1941-8, 223 in 1949 and 258 in 1950.

In 1948, for instance, pressed beef from a food factory was responsible for four separate outbreaks of staphylococcal food poisoning, and another large-scale outbreak, due to staphylococcal toxin, was traced to the glaze on a meat pack. These outbreaks are described in Chapter VI.

Table X gives some of the major outbreaks which occurred in 1950-1 and which were traced to the consumption of contaminated meat.

**Canned food.** Canned food is rarely a cause of food poisoning unless the contents of the tin are contaminated with food-poisoning bacteria after the tin has been opened. The general standard of canning is high and it is unusual to find that either under-processed cans or those which suffer from structural defects have found their way to a kitchen.

Two tins, one of roasted veal and another of carrots in gravy, taken from the Royal United Service Museum and the National Maritime Museum in London, which had formed part of the stores taken by Sir Edward Parry on his Third Expedition in search of the North West Passage in 1824, were opened in 1939 and the contents examined. Both foodstuffs were appetizing, the carrots were sterile and from the canned veal aerobic spore-bearers only were found; this group of organisms is highly resistant to heat and is known to survive for several years under favourable conditions. It seems probable that the strains were derived not from the meat itself but from the starch used to thicken the soup. The spores which had survived in this canned veal would not have grown, because of the strictly anaerobic conditions inside the can, and the contents of the tin could have been eaten with safety.

Occasionally, however, cans are badly manufactured, so that the seams leak, while tins stored for a long time may become rusty and develop pinholes through which contaminating organisms pass. Spoiled tins rarely reach the public; they are usually discovered by the manufacturers before they leave the factory or by sanitary inspectors during routine visits to retail shops.

TABLE X

Major Outbreaks of Food Poisoning Caused by Meat Dishes  
(England and Wales, 1950-1951)

Date	Place	Type of Meat	Infective Organism	Number of Persons Affected
1950	Oxford	Stewed rabbit	<i>Cl. welchii</i>	41
1950	Southgate	Cold boiled salt beef	<i>Cl. welchii</i>	303
1950	Caerleon	Minced beef	<i>Cl. welchii</i>	300
1950	Magor and St. Mellons	Beef stew	<i>Cl. welchii</i>	103
1950	Blackpool	Meat pies	<i>Salmonella</i>	64
1950	Enfield	Cold salt beef	<i>Cl. welchii</i>	100
1950	Morpeth	Pressed beef	<i>Staphylococcus</i>	30
1950	Manchester	Cold roast meat and gravy	<i>Cl. welchii</i>	300
1950	Islington	Boiled salt beef	<i>Cl. welchii</i>	177
1950	Tredegar	Pressed lambs' tongues	<i>Cl. welchii</i>	9
1950	Tredegar	Pressed beef	<i>Cl. welchii</i>	88
1950	S. Westmorland	Jellied meat mould	<i>Staphylococcus</i>	100 +
1951	Manchester	Steamed lamb	<i>Cl. welchii</i>	53
1951	Merton and Morden	Galantine	<i>Cl. welchii</i>	352
1951	Walsall	Pressed beef	<i>Staphylococcus</i>	92
1951	Sandbach	Brawn	<i>Staphylococcus</i>	28
1951	Manchester	Steamed beef and gravy	<i>Cl. welchii</i>	65
1951	Kendal	Ham and tongue	<i>Staphylococcus</i>	35
1951	Uxbridge	Steamed beef	<i>Cl. welchii</i>	35
1951	Darlington	Pressed meat	<i>Staphylococcus</i>	16
1951	Potters Bar	Cold roast meat	<i>Cl. welchii</i>	20
1951	Uxbridge	Stewed steak	<i>Cl. welchii</i>	90
1951	Birmingham	Tongue	<i>Staphylococcus</i>	54
1951	Islington	Meat pudding	<i>Cl. welchii</i>	30
1951	Towcester	Pork pies	<i>Salmonella</i>	43
1952	Portishead	Meat pie	<i>Staphylococcus</i>	33
1952	Leigh	Cold roast beef	<i>Cl. welchii</i>	60
1952	Brentwood	Rissole	<i>Cl. welchii</i>	50
1952	Rothwell and Stanley	Reheated mince	<i>Cl. welchii</i>	219
1952	Manchester	Cold roast pork	<i>Cl. welchii</i>	92
1952	Burton-on-Trent	Ham sandwiches	<i>Staphylococcus</i>	80
1952	Rochford	Cold minced meat	<i>Staphylococcus</i>	60
1952	Winchester	Sausage meat	<i>Salmonella</i>	51

Cl.=Clostridium

The belief that foodstuffs, particularly those of high acidity, must not remain in opened tins arose from the fear of interaction between the foodstuff, tin and air. Nowadays there need be no fear of this phenomenon because most tins are coated inside with a special protective lacquer. Furthermore, there is no reliable evidence that the metal is harmful to the food.

**Sweets.** In the sweet group, trifles, custards and other lightly cooked or uncooked milk and egg dishes, synthetic cream and ice-cream are all responsible for a proportion of outbreaks. Ice-cream can now be regarded as a reasonably safe product and the introduction of certain regulations has helped to bring about this improvement in its hygienic quality. The Ice-cream (Heat Treatment, etc.) Regulations, compiled in 1947, require ice-cream to be heated, then cooled, rapidly frozen and kept frozen until sold; ice-cream prepared with a cold-mix powder—from a liquid mix evaporated after heat-treatment—need not be heated but must be frozen within an hour of reconstitution. Before the institution of these regulations the unheated ice-cream mix was frozen at the convenience of the manufacturer, and food-poisoning bacteria introduced by carriers were provided with excellent conditions for growth; an outbreak is described in Chapter VI.

A further factor which has helped to improve hygienic conditions in the ice-cream trade has been the introduction of a grading system based on tests for the bacteriological cleanliness of ice-cream samples. During the last four years this method of control has been used extensively in Great Britain, and it has led to a marked improvement in the quality of the samples brought for examination. The proportion of Grade 1 samples, of good hygienic quality, has increased, while the proportion of Grade 4 samples, of doubtful hygienic quality has decreased.

In an effort to produce cleaner ice-cream the sanitary inspectors and manufacturers have co-operated wholeheartedly. Premises have been enlarged and redecorated, tiled walls are seen more often, and floor surfaces have been improved. Better equipment has been installed and there have been strenuous efforts to improve the methods of cleaning. It has been demonstrated frequently that thorough cleaning and sterilization of equipment is essential for the production of a high standard of bacterial cleanliness in ice-cream. The bacteriological examination of samples taken from different points throughout the processing plant will help to indicate sources of contamination arising from faults in cleaning procedures; these may be found in the

cooler, in the bucket used to convey the cream from the cooler to the ageing vat, the ageing vat itself or in some other place. To correct these faults there has been much discussion over the relative merits of different detergents for cleaning, and of methods of sterilization by steam, hypochlorite or other bactericidal agents. Interest and competition have been stimulated and there is a corresponding improvement in hygiene.

**Cream.** It may be noted that several of the outbreaks of paratyphoid fever which have occurred in Britain during the past ten years have been associated with the consumption of synthetic cream. The exact method of contamination of the cream has never been discovered, but it is probably via the hands of a healthy carrier or mild case, either in the factory or more often in the bakery. The ingredients of the different types of confectionery cream are subject to wide variation; some of them contain milk products, a small proportion of egg (usually either from the powdered or frozen liquid material) or butter. These substances encourage the growth of bacteria and provide excellent breeding grounds. Other creams, because they contain a high concentration of some ingredient such as sugar, or perhaps because they lack some essential substances for growth, do not encourage bacteria to multiply. Nevertheless, it is very disturbing to see cream cakes handled carelessly in confectioners' shops. In some establishments, particularly in Denmark, where food hygiene is well advanced, the hands are not allowed to come in contact with synthetic cream or other bakery articles. Sweet cakes, which are many and varied, are transferred from counter or shop window to the customer's box or paper bag by tongs, or by other suitable apparatus.

Table XI shows some of the reported outbreaks traced to synthetic cream. Each year outbreaks of bacterial food poisoning and paratyphoid fever arise from this popular article of food; it is clearly desirable, therefore, that it should be protected from contamination.

The investigation of a recent outbreak illustrates the possible chain of spread of infection from an intestinal carrier of salmonella organisms in a bakehouse, through cream buns to the consumer. The synthetic cream was received in tins from the manufacturer, and samples taken on arrival showed the cream, at this stage, to be bacteriologically clean. The buns were made and the cream added in a small hot bakery under the cramped conditions so often found in small bakehouses. Samples of the cream were taken from the mixing

bowl during the process of whipping, from a batch of buns, and finally from the water in which was washed a much-handled cotton bag used to fill the buns with cream; salmonella organisms were isolated from these washings. There had been some delay in the reporting of this outbreak and the samples were not collected until a week had elapsed from the date of the last case. It is possible that the cotton bag had not been properly washed during the week, so that it was still harbouring the batch of organisms responsible for the actual outbreak. It was noticed that the utensils, cotton bag and other apparatus were washed in a bowl or sink of lukewarm water, but that no attempt was made to sterilize them. The infecting organism could, therefore, have remained on these utensils for some time. It is possible that the carriers responsible for the original contamination

TABLE XI

*Outbreaks of Infectious Disease caused by Synthetic Cream  
(England and Wales, 1941-1951)*

<i>Date</i>	<i>Place</i>	<i>Disease</i>	<i>Infective Bacterium</i>	<i>Number of Persons Affected</i>
1941	Bristol	Paratyphoid Fever	<i>Salm. paratyphi B</i>	12
1944	Epsom	Food Poisoning	<i>Paracolon bacilli</i>	3
1946	London	Food Poisoning	<i>Salm. typhi-murium</i>	27
1946	London	Food Poisoning	<i>Salm. thompson</i>	28
1948	Lincoln	Food Poisoning	<i>Salm. typhi-murium</i>	50
1948	Eastbourne	Paratyphoid Fever	<i>Salm. paratyphi B</i>	40
1948	Lambeth	Food Poisoning	<i>Salm. typhi-murium</i>	93
1949	London	Food Poisoning	<i>Salm. typhi-murium</i>	2
1949	Llanelly	Food Poisoning	<i>Salm. typhi-murium</i>	282
1949	Newcastle	Food Poisoning	<i>Salm. typhi-murium</i>	100
1949	Bolton	Food Poisoning	<i>Salm. typhi-murium</i>	60
1950	London	Food Poisoning	<i>Salm. typhi-murium</i>	18
1950	Cardiff	Food Poisoning	<i>Salm. typhi-murium</i>	3
1950	Frimley and Camberley	Food Poisoning	<i>Salm. typhi-murium</i>	75
1950	Exeter	Food Poisoning	<i>Salm. typhi-murium</i>	250
1950	London	Paratyphoid Fever	<i>Salm. paratyphi B</i>	9
1951	Sunderland	Paratyphoid Fever	<i>Salm. paratyphi B</i>	14
1951	Birmingham	Paratyphoid Fever	<i>Salm. paratyphi B</i>	15
1951	Portsmouth	Paratyphoid Fever	<i>Salm. paratyphi B</i>	9

*Salm.* = *Salmonella*

had reinfected the new batch of cream, although there had been no further cases of poisoning. The next step was to find out who was excreting the food-poisoning organisms; a stool sample and a specimen of blood were collected from each member of the bakery staff. One man proved to be a symptomless excreter of the salmonella organisms, and although he himself did not handle the cream it must be assumed that in the general unhygienic state of the bakery the infecting organism had been transferred to his colleague who was responsible for adding the cream to the buns. Utensils were shared by the staff, roller towels were in common use, and the washing-up was carried out in a communal bowl or sink of lukewarm water. The infection could, therefore, have been conveyed indirectly from person to person.

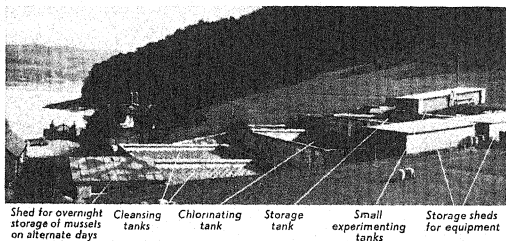


FIG. 8 Shell-fish purification station—Conway

**Fish.** Freshly cooked fish is rarely a cause of food poisoning, but processed or made-up fish products, such as fish pies and fishcakes may be readily contaminated.

The proportion of outbreaks due to fish in 1949 was unusually high, 21 per cent compared with the figure of 7 per cent for 1950 and 11 per cent for 1951, because several outbreaks were caused by the consumption of cockles. The clinical symptoms shown by the patients in these outbreaks suggested bacterial food poisoning although the responsible organisms were not discovered. Shell-fish, and particularly oysters, have been in the past an important source of typhoid infection. Oysters and mussels are often bred or fattened in the sewage-polluted waters of tidal estuaries, and oysters are usually consumed uncooked. From 1919 to 1934 it was estimated that more

than 100,000 cases of typhoid fever due to the consumption of shell-fish occurred in France; 25,000 were fatal. When the danger was realized, a small number of stations, equipped for the purification of shell-fish, were set up in Britain and some other countries. In addition, attempts were made to control the suitability of shell-fish for human consumption by bacteriological methods. Also the water from breeding or gathering grounds is examined for evidence of sewage pollution. Shell-fish imported from other countries should be accompanied by a certificate of bacterial purity.

**Eggs.** The percentage of outbreaks traced to raw or dehydrated eggs varies from year to year. The figure quoted in Table IX for food-poisoning incidents from ducks' eggs (8 per cent) was lower than that recorded in 1950 (16 per cent); there were no incidents from contaminated spray-dried egg because the 1951 imports were greatly reduced.

Precautions to be observed in the use of both ducks' eggs and spray-dried egg will be considered in the section on Prevention. Freshly cooked hens' eggs are rarely, if ever, found to be the cause of food poisoning.

**Milk and cheese.** The figures for food poisoning caused by milk, cheese and other products are usually low; nevertheless an outbreak of staphylococcal enterotoxin food poisoning was traced recently to a large round imported cheese weighing about six pounds. Sandwiches made with this cheese had been given to workers in a factory canteen, and a number of them were taken ill 4 to 5 hours later. When the cheese was examined bacteriologically enormous numbers of staphylococci were found in the centre and on the outside. It seems probable that it was contaminated during the process of manufacture, and that the organisms had not only remained alive, but had multiplied after manufacture.

#### **Food and drink unlikely to cause acute food poisoning**

Certain foodstuffs do not support the growth of bacteria; others may slowly destroy them.

**Jam and similar sweetstuffs.** Among those foods which may be disregarded as a possible cause of food poisoning are preserves such as jam, and also honey and syrup, because they usually contain 60 per cent or more of sugar. Moulds may grow freely on jam, but there is no recorded evidence that a mould has ever been responsible for food



poisoning. Sugar, alone or in the form of icing, does not support bacterial growth.

**Fruit.** Acid fruit dishes, for example cooked apples and plums, alone or in tarts and cordials, will not allow the growth of pathogenic bacteria. It must be remembered, however, that the outside of fruits which are eaten with the skin intact, for example plums, pears, apples, strawberries, raspberries and so on, can serve as vehicles of infection for those organisms which cause dysentery, or the typhoid and paratyphoid fevers.

**Pickles and sauces.** Pickles, sauces and mayonnaise made with vinegar possess a high acidity, and they are not likely to cause food poisoning. Certain bacteria can grow in acid foods and some of these are able to cause spoilage, but none of them is dangerous to man. Dressings and sauces made without vinegar, such as Hollandaise sauce, contain eggs, fat, and flavouring matter only. As they are highly suitable for bacterial growth, they should be prepared with great care and attention to hygiene and they should be eaten within one or at the most two hours of preparation, unless stored in the refrigerator. Ducks' eggs should never be used for such uncooked non-acid preparations.

**Powdered foods.** Dried substances such as flour, custard powder, and blancmange powder are usually safe in the dried state, although on one occasion a well-known powdered mix used to make a certain type of pudding was found to contain salmonella organisms. Recommendations on the use of dried egg and gelatin will be given in a later chapter.

**Fats.** Lard, margarine, butter, and other fats do not encourage the growth of pathogenic bacteria, and they may be disregarded as media for food-poisoning organisms unless they are contaminated with typhoid or dysentery bacilli, when small numbers surviving on the outside may cause infection.

**Bread.** Many people are worried about the contamination of bread, and they regard the handling of unwrapped loaves with concern. Bread is seldom if ever responsible for acute food poisoning; the crust forms a barrier against the invasion of bacteria and, furthermore, the substance of the loaf is far too dry to allow the growth of bacteria unless it is in contact with a moist foodstuff. Bread can assist

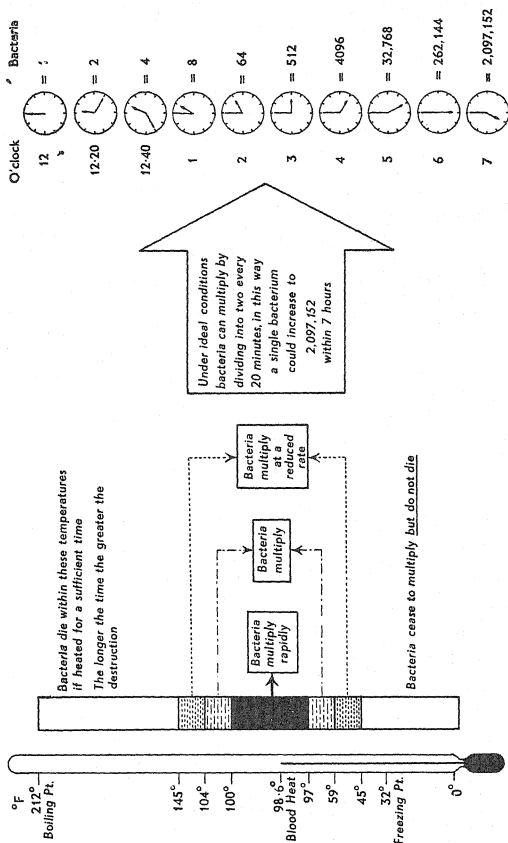


FIG. 9 Effect of temperature on the growth of bacteria. Safe and dangerous temperatures for foodstuffs

in the transfer of dysentery, typhoid or paratyphoid bacilli from an infected unwashed hand but this has rarely been proved to occur.

**Vegetables.** Freshly cooked potatoes and other vegetables may be eaten with an assurance of safety, but it is wise to wash tomatoes, cucumbers, and other fruits, and vegetables which may be eaten raw with the skin intact.

### Favourable conditions for multiplication

The onset of acute food poisoning is caused by food in which large numbers of certain bacteria have multiplied or are still multiplying. We may swallow small numbers of staphylococci, or even small numbers of salmonella, without ill effect, but our natural resistance cannot withstand the toxic substance from millions of staphylococci growing in food nor the infection from a large dose of salmonella.

The length of time necessary for food to reach a dangerous state of contamination will depend on three factors. The nature of the food, the prevailing temperature, and the number of bacteria originally implanted.

At 37°C. (98.6°F.) or blood heat, the growth of food-poisoning bacteria is most rapid, with the division of each bacterial cell into two every 20 to 30 minutes. At room temperatures of 18° to 20°C. (64° to 68°F.) the multiplication rate is much slower, and at temperatures below 10°C. (50°F.) growth is inhibited but the germs do not all die (Fig. 9). Outbreaks of food poisoning are, therefore, more common in the summer than in the winter. Fig. 10 shows the

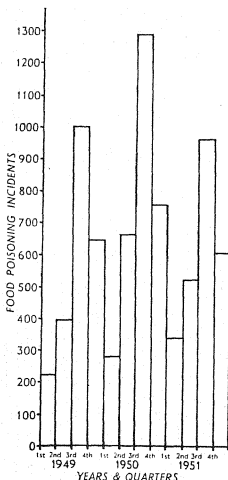


FIG. 10 Seasonal prevalence of food poisoning

rise in the incidence of food poisoning during the summer quarters of the years 1949-51.

With the exception of a small group of thermophilic (heat-loving)

bacteria which grow at temperatures up to  $55^{\circ}\text{C}$ . ( $131^{\circ}\text{F}$ .) or higher, there is little growth above  $40^{\circ}\text{C}$ . ( $104^{\circ}\text{F}$ .) and at  $60^{\circ}\text{C}$ . ( $140^{\circ}\text{F}$ .) most bacteria are killed.

Moisture is also a necessity for growth. Bacteria do not grow, although they exist, in foods containing less than 15 per cent of moisture, for example, spray-dried egg, gelatin and custard powder.

A food-poisoning outbreak due to the presence of large numbers of salmonella organisms in rehydrated egg mix which had been allowed to stand for some hours in a warm kitchen is described in Chapter X. An experiment was carried out on the rate of growth of 3,000 staphylococci added to dry and rehydrated egg powder when the inoculated powder and mix were allowed to stand at two different temperatures,  $30^{\circ}\text{C}$ . ( $86^{\circ}\text{F}$ .) and  $20^{\circ}\text{C}$ . ( $68^{\circ}\text{F}$ .), for varying periods of time. The number of staphylococci in the powder remained almost stationary, while in the reconstituted egg the number rose to approximately 8 million per gram after 16 hours at  $30^{\circ}\text{C}$ . ( $86^{\circ}\text{F}$ .), and to 410 million after 24 hours at this temperature. At  $20^{\circ}\text{C}$ . the rate of growth was much reduced and the count at 16 hours was approximately 65,000 and at 24 hours 2 million per gram.

The rate of multiplication of staphylococci in a made-up meatstuff veal loaf, at the same two temperatures,  $30^{\circ}\text{C}$ . and  $20^{\circ}\text{C}$ ., was also investigated. The original count of approximately 4,500 per gram increased to 230 million in 8 hours, and 2,900 million in 24 hours at  $30^{\circ}\text{C}$ . and to 4 million in 24 hours at  $20^{\circ}\text{C}$ . There may be sufficient toxin present to cause illness after storage for one day at  $30^{\circ}\text{C}$ . but at a lower temperature a longer period would be required. It is, therefore, clear that storage of susceptible foodstuffs at low temperatures retards the growth of bacteria and thus prevents food becoming dangerously contaminated.

### **Variation of the dose of organisms required to produce symptoms**

In general, it is assumed that acute food poisoning occurs when large numbers of certain bacteria are proliferating in susceptible foodstuffs. Small numbers of staphylococci may be eaten without harm, for there will be insufficient toxin present to cause symptoms.

Similarly it is probable that small numbers of salmonella organisms may be eaten without ill effect, although recent experiments carried out in the U.S.A. with salmonella isolated from dried egg showed

that there is a wide variation (*a*) in the dose of organisms required to produce illness in man, and (*b*) from one salmonella species to another.

There was even a great difference in the infective dose for individual strains of the same species of salmonella. One strain might cause illness when 600 thousand organisms were taken in food, and another strain only when more than 67 million organisms were eaten. In all instances the number of organisms required to produce illness could reasonably be encountered in practice. During the course of the experiments many of the volunteers became intestinal carriers of the salmonella organisms without any sign of illness; sometimes the carrier state persisted for many weeks.

## CHAPTER VI

### EXAMPLES OF OUTBREAKS OF FOOD POISONING

The occurrence of food poisoning depends on a peculiar set of circumstances, when the following essential factors must be present:

1. The infecting organism, carried by the human or animal body.
2. The contaminated hands of the carrier, or a contaminated animal product, or some kitchen utensil or article of equipment similarly contaminated.
3. The vehicle or food.
4. The correct conditions of temperature, time and moisture for the growth of the organisms in food.
5. The susceptible group of people.

The investigation of food poisoning depends on the ability to find out the details relating to each of these five factors. In Britain, food poisoning is a notifiable disease under the Food and Drugs Act, 1938, and the local Medical Officer of Health must be informed of all cases and outbreaks. The investigation is then a matter for Medical and Sanitary Officers, and bacteriologists. The sooner an outbreak is notified to the authorities the greater the chance of recovery of the germs responsible for the outbreak from the patient's vomit or stool and, what is more important still, from the remains of the contaminated foodstuff.

The collection of the relevant information about the clinical nature of the outbreak, incubation period, numbers affected, those at risk, and the type of food suspected, is most important.

The clinical symptoms and incubation period should indicate whether the illness is due to the toxin or infection type of bacterial poisoning. An important part of the inquiry is to find out the foods eaten in common by all the patients, and those eaten by the people who remained well, although it must be remembered that not all those at risk through eating the contaminated meal will necessarily fall sick.

It is important that immediately any information about food poisoning is received the kitchen staff should be warned not to throw any foodstuffs away. The cause of many food-poisoning

incidents has been obscured because left-over remains of foodstuffs have been discarded before the investigator arrived. The identification of infective bacteria in contaminated food gives the key to the solution, and enables those who are investigating the outbreak to find out errors of hygiene in the handling and preparation of food. Investigations are designed to help canteen organizers, cooks, and others so that errors which they unknowingly commit may be avoided in future. In no sense are they blamed for occurrences which may have been quite beyond their knowledge and control.

As already pointed out, the suspected food is often to be found among prepared meats, warmed-up dishes, lightly cooked egg or milk products, synthetic cream, and other foods which are suitable for bacterial growth and which may have been left for some hours at a warm temperature. If a suspected foodstuff is not available for examination, then it is desirable to know the ingredients of the food, whether it contains, for example, dried egg, so that powder from the same packet as that used in the cooked product can be examined. If this is impossible, then a sample from a similar packet should be examined.

If the nature of the outbreak suggests that it is due to a salmonella organism then stool samples from all patients and food-handlers will be taken, and inquiries made about vermin and the possibility of naturally contaminated meat. If staphylococcal toxin is the suspected cause then stools and vomit from patients, and nose and hand swabs from the food-handlers, may reveal the same type of staphylococci as found in the foodstuff. If infection is traced to one or more food-handlers, then the sanitary conditions of the food establishment and the kitchen arrangements, the handling and the storage of the food should be carefully examined.

Examples of some typical food-poisoning outbreaks are given in the next few pages. In the first, a straightforward outbreak of staphylococcal toxin food poisoning, the sequence of events could easily have been prevented if those responsible for the preparation of the food had understood the factors causing the contamination.

### **The ham sandwich outbreak**

A coach-load of people left London one summer morning on their way to the coast for a day's outing. They took with them, for their lunch, ham sandwiches cut and prepared at a public-house in the home area. Before they had travelled far many had started to eat their sandwiches, and as they were nearing the coast the first victim began to feel ill; soon other members of the party were unwell. When they

arrived at the coast the illness was acute and several people were taken into the local hospitals.

News of the outbreak soon reached the Medical Officer of Health for the area, and the coach was searched for remains of the food; fortunately, one or two ham sandwiches were found. Specimens of stool and vomit were collected from the patients who had been taken to hospital, and these specimens were submitted to the local public health laboratory. The following day investigations were started by the Medical Officer of Health in London, inquiries were made at the public-house where the sandwiches had been prepared; those responsible for making them were questioned as to the method of preparation and the source of the ham. Samples of the ham used in the preparation of the sandwiches were available, and were submitted to the laboratory for bacteriological examination. The bacteriologists at the coast town found large numbers of staphylococci in ham from the sandwiches retrieved from the coach, and staphylococci were found in the vomit and faeces of the patients who were in hospital. At the same time another laboratory found staphylococci in the remains of the ham taken from the public-house. When all these strains of staphylococci were compared, they were found to belong to the same type, the one usually associated with foodstuffs suspected of causing staphylococcal enterotoxin food poisoning. It transpired that the woman who had prepared the sandwiches had taken home a small portion of the ham which both she and her husband ate for supper; they were taken violently ill and removed to hospital by ambulance. The strains of staphylococci isolated from these patients proved to be the same type as those isolated from the specimens in the coast town and in London. The next step was to discover how these organisms had contaminated the meat.

The ham was cooked and prepared at the public-house; it was stored in a refrigerator which was out of action, and the contaminating organisms had multiplied freely in the useless refrigerator during the warm days of storage. It might be thought that the salt concentration of ham would prevent the growth of the organism, but staphylococci, unlike many other organisms, can tolerate a high percentage of salt, and in such cured foodstuffs they can multiply and produce their poisonous toxin as usual.

The ham used in the sandwiches issued to the coach party was heavily contaminated with staphylococci, many millions per gram, and the rapid and violent onset of symptoms showed that there must have been a high concentration of toxin present.

The isolation of staphylococci from the faeces and vomit of patients



confirmed the diagnosis, and later the origin of the organism was traced to the nose of the woman who prepared the sandwiches. It is worth noting that the carrier herself was a victim of the toxin formed by the organism she had unwittingly transferred from her nose to the ham. Immunity to the powerful toxin which certain staphylococci produce during active multiplication in foodstuffs is not acquired while the organism is resident in the nose or throat.

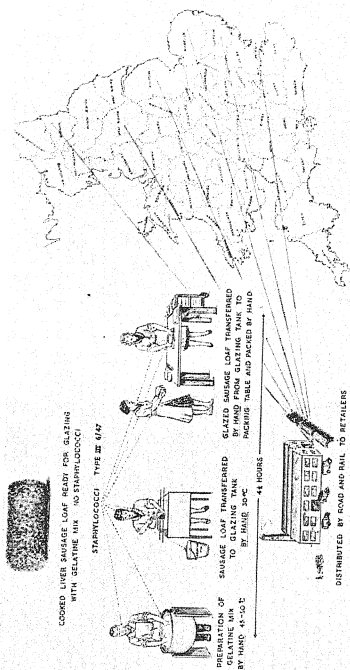
It is not easy to cure this carrier condition; in some instances it may be possible, but in others it is better for the carrier to be transferred to other work.

### **The contaminated glaze outbreak**

In another widespread outbreak of food poisoning due to staphylococcal toxin, the glaze on the outside of liver sausage loaves became heavily contaminated with staphylococci of a food-poisoning type. This foodstuff was prepared on a large scale by a factory, and the meat loaves were distributed over a wide area of the country. More than four hundred cases were reported in this outbreak, and there may have been many hundreds more which remained unnotified.

Large numbers of specimens of the liver sausage loaf were sent to the laboratory from various parts of the country, and each specimen told the same story. The glaze contained up to a hundred million per gram of staphylococci, whereas the meat part of the loaf was almost free from organisms. It was clear that the meat loaf had been correctly processed, that it was free from contamination, and that the glaze only had been contaminated during the process of manufacture. A visit was made to the factory and the methods employed were watched from beginning to end. At the same time swabs were taken from the nose, hands and any lesions or spots of all the personnel engaged in the processing, glazing, or packing of the meat loaf. Swabs were also taken from utensils, table-tops, the glaze itself and its various constituents during the course of manufacture. Faults in the method of making the glaze were obvious. The operative, his shirt-sleeves rolled up to the elbow, blended each ingredient by hand in a steam-jacketed container; the temperature of the mix never rose above 50° C. (122° F.), so that contaminating organisms from the hands would not be killed at any stage in the preparation.

The process of glazing took several hours during the day; it was carried out with the help of a jug continually dipped into the glaze contained in a tank. The glaze was then poured over the minced liver loaf which rested on a grid above the tank. The bulk supply of the



# LESSONS LEARNT FROM OUTBREAK

1. ALL CONTACT OF HANDS WITH FOOD SHOULD BE AVOIDED
2. PERSONNEL WITH SEPTIC FINGERS, OR OTHER SKIN LESIONS, ACUTE COLD, OR ABDOMINAL UPSETS WITH DIARRHOEA, SHOULD NOT ENGAGE IN FOOD HANDLING
3. THE NOSE IS THE RESERVOIR OF STAPHYLOCOCCI AND AN INFECTION MAY BE CONVEYED FROM NOSE TO FOOD VIA THE HANDS
4. HANDS MUST BE WASHED FREQUENTLY, PARTICULARLY AFTER VISITING THE W.C. THERE SHOULD BE HOT RUNNING WATER, ANTISEPTIC SOAP AND PLentiful SUPPLIES OF CLEAN TOWELS, OR PREFERABLY DESTRUCTIBLE PAPER TOWELS, ON AN ENCLOSED ROLLER TOWEL
5. ALL COOKED FOODS AND MADE-UP FOODSTUFFS INCLUDING FILLINGS AND GLAZES, INTENDED TO BE EATEN COLD SHOULD BE GIVEN SUFFICIENT HEAT TREATMENT TO RENDER THEM STERILE OR FREE FROM VEGETATIVE BACTERIA
6. COOKED FOODS NOT INTENDED FOR IMMEDIATE CONSUMPTION, SHOULD BE WARMED OR COVERED AND KEPT AT A TEMPERATURE NOT HIGHER THAN 40° 10°C
7. FOOD CONTAINERS AND UTENSILS SHOULD BE WASHED IN HOT WATER CONTAINING A GOOD DETERGENT AND RINSED IN WATER AS HOT AS POSSIBLE NOT LESS THAN 80°C. AN ANTISEPTIC, E.G. HYPOCHLORITE, COMBINED WITH THE DETERGENT IS AN ADVANTAGE
8. FOOD COUNTERS AND UTENSILS AFTER RINSING IN HOT WATER 80° 90°C SHOULD BE ALLOWED TO DRAIN AND NOT DRIED WITH A CLOTH, WHERE IT IS ESSENTIAL TO WIPE THEM, CLOTHS SHOULD BE WASHED AND BOILED DAILY

Fig. 11 The contaminated glaze outbreak of food poisoning—staphylococcal toxin

glaze was kept in the large jacketed container while the glazing was in progress, and the small tank which supplied the well for glazing was replenished when necessary from the bulk supply, kept at approximately  $34^{\circ}\text{C}$ . ( $109.4^{\circ}\text{F}$ .).

The outbreak took place during the warm spell of weather in June, when conditions were ideal for the multiplication of the contaminating staphylococci. The glaze afforded an excellent medium for bacterial growth; furthermore, it appeared that glaze left over from one day's work might be kept overnight in the refrigerator and added to the fresh batch of glaze made the following day, therefore serving as an inoculum.

The factory was visited a week after the outbreak had occurred. By this time the infecting organism was fairly widespread in the environment of the glazing and packing room. Four people were carrying it in the nose and on the hands, and swabs from portions of equipment and the paper used for packing the meat loaves showed small numbers of the same food-poisoning staphylococcus. After any large outbreak of food poisoning the infecting organisms may be widely dispersed around the kitchen and canteen. There are many chances for the spread of infection from the handling of communal utensils and other equipment, and the use of communal roller towels. It is therefore necessary to take series of specimens from the suspected carriers, in order to differentiate the transient from the persistent carrier who is likely to cause future trouble.

In this particular outbreak the follow-up of the suspected carrier revealed that the worker engaged in preparing the glaze was a persistent nasal carrier of the infecting type of staphylococcus. He was transferred to another job which did not involve the handling of susceptible foodstuffs.

It was necessary also to take measures to free the particular part of the factory from the staphylococcus and it was agreed that temporarily the glazing operation should be stopped and, provided precautions were taken to minimize the risk of a similar occurrence, it could be restarted at a later date.

In order to minimize the risk of recurrence of dangerous contamination of the glaze, it was recommended that the hands of the operatives should not come in open contact with the glaze during or after preparation, and that after the ingredients had been added the glaze mix should be brought to the boil. It was suggested that glazing should be carried out in a cool room and that the temperature of the glaze during this process should be maintained at approximately  $60^{\circ}\text{C}$ . Any glaze left over after the day's work should be discarded.

THE DANGEROUS PRACTICE OF HANDLING COOKED FOODS

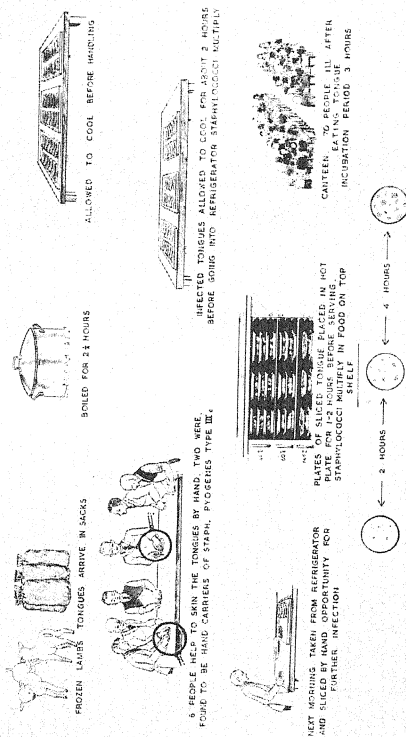


FIG. 12 The lambs' tongues outbreak of food poisoning—staphylococcal toxin

General suggestions with regard to personal hygiene, care of staff, cleaning of equipment, heat-treatment and cold storage of foods were also given.

### **The lambs' tongues outbreak**

Another outbreak of food poisoning which occurred in a factory canteen was due to contamination of lambs' tongues, during the process of "skinning", by staphylococci from the hands of two members of the kitchen staff. The frozen tongues after arrival at the canteen were allowed to thaw; they were then thoroughly cooked and there is no reason to doubt that they were more or less sterile when taken from the boiler. The cooked tongues were laid carefully in rows on enamel trays and allowed to stand on a table in the kitchen until cool enough to handle, when six people stood around the table and removed the skin from each tongue, using hand and knife. The skinned tongues were again placed in rows on enamel trays and allowed to stand in the kitchen for a further period, before refrigeration overnight. Early next morning they were taken out and sliced by one man. The slices were added to the dinner plates which were then placed in the hot-plate container ready for lunch at midday. Later investigations showed that although the lower two shelves of the hot cupboard were maintained at a temperature which would kill most bacteria, the temperature of the top shelf was much lower, in fact suitable for bacterial multiplication. A few cooked tongues not used for the meal were stored in the refrigerator. They were examined at the laboratory and found to contain large numbers of staphylococci of the usual food-poisoning type.

A few days after the outbreak a visit was made to the factory canteen in order to find out the ways in which infection had spread. It was a large factory and many people were involved in the work of the kitchen, nevertheless swabs were taken from the nose and hands of all of them, also from table-tops, floor, and other relevant places; samples of dust were also collected.

Staphylococci were isolated from swabs of table-tops and from dust even after instructions had been carried out that all surfaces should be cleaned with detergent and sterilized with hypochlorite solution. The tables were wooden and it seemed impossible to eliminate bacteria from the nooks and crannies of these wooden surfaces. Two hand carriers of the infecting strain of staphylococcus were found amongst those responsible for skinning the tongues. Nose and hand swabs were taken from the two carriers at weekly intervals for several months. The organism was persistently cultured from their hands

although there was no evidence that it was present in the nose. Finally, when drastic measures were used, such as exposure to ultra-violet light and the application of flavine to the hands, negative swabs were obtained. In the meantime neither carrier was allowed to handle food known to encourage the growth of micro-organisms.

### **Poisoned ice-cream**

Before the institution of the Ice-cream (Heat Treatment, etc.) Regulations, 1947, the chance contamination of ice-cream mix by carriers of intestinal pathogens, nasal and hand carriers of staphylococci and other nose and throat organisms capable of causing disease was far more dangerous than at present. In those days there was time for contaminating organisms to multiply in the mix before it was heated or after heating before it was frozen and thus outbreaks of infection and toxin poisoning occurred. In 1945, for instance, staphylococci carried in the nose and on the hands of a worker in the cookhouse of an army hospital were introduced into batches of ice-cream mix after the ingredients had been cooked. The mix was allowed to cool slowly overnight and 20 to 30 hours elapsed before freezing; the staphylococci multiplied abundantly and formed enough harmful toxin to affect 700 people at least. Had the mix been frozen very soon after it had been cooked, as required by the present Regulations, there would have been no opportunity for the organisms to multiply, the toxin would not have been formed and the food poisoning would not have occurred.

### **The goats' milk cheese outbreak**

In the spring of 1944 a family outbreak of staphylococcal toxin food poisoning followed the consumption of cheese made from goats' milk; it was the first of its kind to be reported in this country. Of six people, the five who became acutely ill 4 to 5 hours after tea, had all eaten cheese made from goat's milk; the sixth, who escaped illness, had not eaten the cheese. Samples of this cheese showed the presence of many millions of staphylococci per gram and the same type of staphylococcus was found in the faeces of one of the patients. The cheese was made by adding rennet to fresh goats' milk; the whey was strained through a clean muslin bag and the cheese pressed into shape. Throat, nose and hand swabs from those concerned in the milking and the cheese-making failed to reveal staphylococci and there were no lesions on the hands of the milker or on the udders or teats of the goats. Yet from the freshly drawn milk of one goat the same type of

staphylococcus was isolated, and it was assumed that multiplication of the organisms had taken place in the milk. Furthermore, extracts of the staphylococci isolated from the cheese produced violent symptoms in a human volunteer.

### **The spoiled pressed beef**

The following account of an outbreak of food poisoning due to contaminated pressed beef provides a further illustration of the difficulty of satisfactorily sterilizing wooden table-tops.

The outbreak occurred during the war in a central factory responsible for distributing pressed meat of various types to subsidiary firms in different counties. Complaints had been received that the meat packs were arriving at their destination not only softened and with the gelatin liquefied but that they had caused mild food-poisoning symptoms. The complaints had continued for some weeks before the laboratory was asked to investigate the trouble. The manufacture of the pressed meat was watched from beginning to end, specimens were taken, and from the bacteriological results the following story was pieced together.

The meat, often of a poor quality, arrived frozen; it was allowed to thaw, and cut up into convenient portions on a large wooden table in a room which also contained the boilers. The meat was then placed in the brine tanks which were built into a corridor leading from the workroom. After some days in the pickle solution the meat was removed from the brine, and allowed to rest on the wooden table, before being transferred to the boilers. It was cooked for two hours, then taken from the boilers, allowed to cool on the same wooden table, cut up into small pieces and placed in the press tins by hand. When each tin was packed, a solution of gelatin was poured over the meat and a lid pressed on top by means of a clamp. These tins of meat were allowed to cool and set slowly overnight in an adjoining room.

The specimens examined in the laboratory revealed that the organism responsible for the liquefaction of the gelatin, *Proteus* by name, was present on the wooden table, in the brine tank and in several specimens of cooked meat. *Proteus* organisms are widely distributed in nature, and whatever their origin they had now become established in the wooden crevices of the working table.

The salt solution in the brine tank was far below the recommended strength, and instead of inhibiting the organisms it allowed them to thrive in large numbers. The chunks of pickled meat were taken from the brine tank and allowed to rest on the wooden table. The

contaminated salt solution seeped into the rough surface, and the infecting organism remained in the cracks in spite of the thorough washing, scrubbing and treatment with chlorine solution which was recommended. The cooked meat coming straight from the boilers was bacteriologically sterile, but it was soon contaminated with *Proteus* from the table, and also no doubt from the hands of the operatives.

Unaware of the dangers associated with the handling of meat, the workers placed both hands on the surface of the meat and gelatin mix in the closely packed tins in order to press the meat well down before applying the lid. The warm meat coated with gelatin left at room temperature overnight provided the ideal medium for the growth and multiplication of bacteria, and it was not surprising that the gelatin had started to liquefy by the time the packs had reached their destination.

Two main recommendations were given. The first was to replace the wooden table by one with a hard impervious surface, which could be easily cleaned, and which could be used exclusively for cutting up the cooked meat into pieces for the press tin; a chopping block or other wooden surface was considered essential for carving up the freshly thawed meat. It seemed possible also to transfer the chunks of meat straight from the brine tanks to the boilers without resting them on the table. The second recommendation was to increase the strength of the brine in the pickle tank to discourage the survival of the spoilage organisms.

### **The pressed beef outbreaks**

A group of outbreaks due to staphylococcal toxin food poisoning from contaminated pressed beef are worth relating, because once again the danger which may arise from much-handled cooked meat allowed to cool slowly overnight at room temperature is emphasized.

During the warm summer of 1948, four outbreaks of food poisoning were reported almost simultaneously. At first, there seemed no connection between them; one had occurred on an express train speeding North, another at a wedding party held at an East coast town, another at a South coast resort, and the last in London. Specimens of food soon began to arrive at the laboratory; they included pressed beef which had been eaten by those affected in all four outbreaks. Large numbers of staphylococci of the usual food-poisoning type were isolated from the samples of cold pressed beef. In the meantime the Medical Officer of Health and sanitary inspectors of the



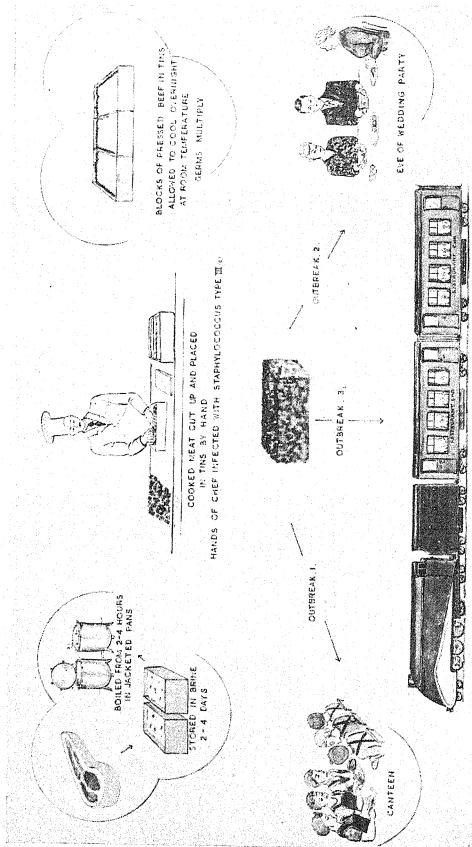


FIG. 13 Pressed beef outbreak of food poisoning—staphylococcal toxin

local authorities had traced the origin of the various supplies of pressed beef to one particular factory. The factory was owned by a well established and reputable firm of food manufacturers, who were astonished at the suggestion that they might have been responsible for careless food-handling. They co-operated willingly and were genuinely anxious to find the cause of the trouble.

As usual the process of manufacture was watched from beginning to end. Samples of meat were collected at every stage of manufacture of the pressed beef, together with nose and hand swabs from all those in any way connected with its production; swabs from tables, utensils, and press cans were also taken. The laboratory results showed that the infecting strain of staphylococcus was present in specimens of meat only after they had been handled in the process of filling the press cans, and the chef who was responsible for this procedure was the only member of the staff who was carrying the infecting organism on his hands. It seemed that he had been doing the work for many years, and it is indeed strange that no trouble had arisen before, unless it is assumed that he had only recently become a hand carrier of a food-poisoning type of staphylococcus. It is often difficult to convince carriers of potentially pathogenic bacteria of the truth, because they have little or no knowledge of the dangers of contamination by bacteria nor of any part that they themselves may play in the spread of infection.

The brine tanks contained salt solution of the correct strength (16 to 18 per cent) and no staphylococci were found in them, nor were these organisms isolated from the samples of raw meat examined, while meat taken from the boiler was practically sterile. Only the chef's hands and the utensils used by him yielded the toxin-producing staphylococcus. His hands and nose were swabbed for many weeks; the hands were invariably positive, a few staphylococci were found in the nose on one occasion only. Many ways were tried to rid the hands of the staphylococci without success.

The problem was temporarily solved by a change in the method of manufacture of the pressed beef.

As illustrations of food poisoning due to organisms of the salmonella group, six outbreaks are quoted.

#### **Salmonella outbreak at an aerodrome**

An outbreak of diarrhoea and vomiting affecting about 100 out of a possible 400 persons occurred in a construction camp. The first case, a member of the canteen staff, continued on duty for five days

before being confined to bed. Three days later a second member of the canteen staff was taken ill, but remained on duty. During the following two days the outbreak spread to members of the camp itself, and further members of the canteen staff were attacked. A salmonella organism of a type rarely found was isolated from the faeces of 19 patients. This organism had not hitherto been isolated in Britain from any other source than dried egg, and it had never been associated with food poisoning in this country. It was probable that the infected food was eaten in the canteen at supper on the day previous to the outbreak. Although large quantities of dried egg were used in the canteen for various purposes none was served for the suspected supper. Nevertheless, the outbreak among the canteen staff probably originated from the consumption of a dried egg dish—unfortunately no dried egg was available for examination.

The supper dishes included cold meat, either corned pork, cold lamb, or cold beef together with lettuce, tomatoes, cucumber or beet-root with bread and cheese, and jam, and tea to follow. It would appear, therefore, that the salad or cold meat was contaminated from one or more of the canteen staff who were suffering from diarrhoea at the time and who were symptomless carriers.

### **The contaminated sandwiches**

During the winter of 1947, seventy-nine persons living in a hostel for working men and women complained of severe gastro-enteritis. All except five of the cases were among the male residents and it was the habit of many of the men to take sandwiches for lunch, whereas the women did not. Suspicion therefore fell upon the sandwiches as the vehicle of infection.

The sandwiches were prepared by a Miss X who had complained of intestinal disturbances about five days before the outbreak and who was found subsequently to be infected with salmonella organisms. The sandwiches, consisting of Bovril, potted meat, or reconstituted dried egg were prepared on the afternoon of 8th December. Between preparation and issue the following morning the sandwiches were stored at room temperature in covered trays. Every male resident who became ill had eaten some of the sandwiches for lunch. A few sandwiches were issued from the canteen "Tea-bar" during the evening of 8th December, and it is probable that the five women patients were infected in this way.

The contents of an almost empty bottle of Bovril were examined in the laboratory and found to contain very small numbers of salmonella organisms. It was assumed, therefore, that all

the sandwich fillings had been infected from the contaminated hands of Miss X, although a heavy growth of organisms would be expected only in the potted meat and reconstituted egg, which provide excellent food for bacteria whereas Bovril inhibits their growth. Unfortunately, no potted meat or dried egg was available for examination.

How was Miss X originally infected? There had recently been an unexplained and rapid diminution of the mouse population in the hostel, which suggested the possibility of epidemic disease amongst the local rodents. In partial confirmation of this suggestion a mouse caught in a trap was found to be infected with the same type of salmonella. It is not unlikely, therefore, that the infection of Miss X was of mouse-borne origin.

There were three factors in the hostel which predisposed the susceptible population to an outbreak of food poisoning—the presence of rodents infected with salmonella, a food-handler who became an ambulant case of salmonella infection, and suitable food exposed to time and temperature conditions which would encourage the growth of the organisms.

### **Infected carcasses**

It is known that salmonella organisms may be carried into slaughter-houses by animals the carcasses of which after death show no outward sign of disease by routine methods of meat inspection. There are healthy faecal carriers of salmonella among animals and furthermore the carcasses of animals which have died of salmonella infection sometimes bear little evidence of the cause of death. From time to time, therefore, infected carcasses reach the meat factory or retail shop, where they are made into sausages or pies, or cut up and sold. In 1948 several families suffered from salmonella food poisoning after eating lightly cooked or uncooked sausages. Organisms of the salmonella group were found in sausages recovered from various sources.

The prevention of such an outbreak demands strict rules for the thorough cooking of sausages and sausage meat, while the dangers of eating raw or under-cooked meat must be stressed. The need for improved hygienic standards of slaughter-houses, factories, and retail shops is apparent when it is considered how many opportunities exist for the spread of infection in these places. An example of an outbreak caused by the spread of infection from the retail sale of contaminated meat is given in Chapter IV, page 26.

### **The contaminated ham outbreak**

An unusual outbreak of salmonella infection occurred one September when forty-nine residents in two small adjoining towns developed diarrhoea and vomiting after eating portions of a large, 14-lb. cooked ham from a tin container. The time between ingestion and onset of symptoms varied from 4 to 5 hours, and an unusual organism of the salmonella group was isolated from the actual substance of the remainder of the ham, from portions of ham recovered from purchasers, and from stools of all those who developed gastroenteritis.

The ham, part of a large consignment of 240 tins received from the Continent, had been preserved with salts in the usual way and pasteurized, that is, given a light heat treatment, not calculated to sterilize, but to produce the best cooking result with regard to appearance and flavour. Although sealed in a tin for transport purposes such hams cannot be compared with most tinned foods which are given sufficient heat under pressure to kill all bacteria including those which are most heat-resistant—sterile packs such as these can withstand storage for several years under atmospheric conditions. The manufacturers of pasteurized hams do not intend them to be regarded as sterile packs for many tins are marked "Keep in a cool place", and sometimes "Perishable keep under refrigeration".

It is reasonable to suppose that the ham in question was already infected or became contaminated during preparation for packing—in fact before it was cooked—and that subsequent heat-treatment failed to kill the contaminants. The bacteriological examination of many samples of ham from pasteurized packs has shown the presence of numerous bacteria of various types. If conditions of storage are poor and the tins are stored at warm, atmospheric temperatures, many become blown and spoiled by these contaminants.

### **The Queen's pudding outbreak**

Another outbreak in 1949 affected about 136 hospital nurses, domestic staff and patients with acute food-poisoning symptoms from 24 to 96 hours after they had all eaten a particularly appetizing pudding in which the chief ingredients were egg yolk and milk. The yolks of 200 ducks' eggs had been beaten with milk and added to breadcrumbs; the mixture was baked for 35 minutes, when it became semi-solid. The top was then smeared with hot jam and covered with a layer of beaten-up white of egg mixed with a boiling saturated

solution of sugar, and the pudding was returned to the oven for the top to be browned.

All those who ate the pudding became ill, including the family of a member of the kitchen staff who had taken some home.

It was generally agreed that the infection with salmonella organisms had originated from contaminated ducks' eggs and that the temperature used to cook the contaminated pudding had not been sufficient to kill the bacteria, which could have been present both in the mixture containing the egg yolk and the egg white. The eggs had been collected from sixteen Essex farms, and the task of detecting the particular ducks responsible for the contaminated eggs was not practicable. Furthermore to destroy the duck population of sixteen farms would have entailed an economic loss out of all proportion to the chance occurrence of a food-poisoning outbreak on the same large scale.

The warning to cook all ducks' eggs thoroughly, for at least 10 minutes if they are boiled, and thoroughly both sides if fried, or better still to use them only for well-cooked foodstuffs such as baked fruit cakes or steamed puddings, is frequently given. Lightly baked puddings, meringues or other foods which may require little or no cooking should never be made with ducks' eggs for they constitute a potential danger to the consumer, particularly the very young, the aged, and the invalid.

### **The contaminated pies outbreak**

This outbreak is concerned with the bulk infection of meat filling for pies.

At the end of July 1949, 260 pies and 450 sausage rolls were made by a Midland firm and distributed to twelve branches. Of those who ate the pies 29 of 11 family groups and 21 scouts at camp in Scotland became acutely ill with food-poisoning symptoms 5 to 24 hours later, while those who ate the sausage rolls were unaffected. A dog fed with the remains of a pie which gave rise to human cases developed acute gastro-enteritis.

Twenty-one of the 27 members of the scout camp were taken ill their first night in camp. Rain which started heavily that night continued for six days; the latrine had been dug in a distant part of the field. For nearly three weeks the camp was never free of invalids, some of whom developed high temperatures and were transferred to the local hospital and houses in the district. In two cases recovery was not complete until October.

Organisms of the salmonella group were isolated from the stools

of patients, from a symptomless excreter and from thirteen meat pies. There were both large and small pies, but the attack rate was higher among those who ate the large pies on the first day after manufacture, although by the second day the small pies had become capable of giving rise to severe diarrhoea and the severity of illness varied with the quantity of pie eaten.

The bakery at which the pies had been made employed about 100 persons; their standard of cleanliness was high and there was good sanitary accommodation.

The same consignment of meat had been used for both pies and sausage rolls; it had been minced, seasoned and mixed with "filler". The prepared meat was hand-filled into the pastry blocks by three persons. The pies were baked for 25 to 30 minutes at 450° to 475° F. and the gelatin was added after baking; sheet gelatin was soaked in water, dissolved in fresh boiling water, cooled and filled into the pies from a jug. The pies were stored at room temperature overnight and distributed next day. It seemed that the cooking time and temperature were adequate to sterilize the sausage rolls but not the pies. The higher attack rate from the large pies eaten on the first day of manufacture indicates that the heat penetration into these pies was slower than for the small ones and that therefore more bacteria survived the cooking in the large pies.

An examination of stool samples showed that one of the three pie makers was excreting salmonella organisms. She may have been responsible, or she may have been herself a victim through eating raw pie meat as was her custom. Specimens of sheet gelatin, washings from the tin used for the gelatin, a mouse trapped in the bakery, and specimens from six batches of pies prepared subsequently were examined bacteriologically with negative results.

Conditions in the butcher's shop from which the meat was obtained were far from satisfactory, although it was impossible to find out whether the infection had arisen from this source, or whether a single infected carcase was used for the preparation of the minced meat used for the particular pies. The ultimate source of the infection was never revealed; it may have been the transitory human excreter as she hand-filled the pie case with meat, or it may have been derived from the pie meat itself.

Food-poisoning outbreaks due to meat pies occur from time to time and it seems that they will continue to do so unless it is ensured that the time and temperatures of cooking are such that the raw meat is not only cooked, but also sterilized, even though the pastry may become over-brown in consequence. The use of pre-cooked meat in

pies is not a safe alternative, because heat-resistant spores may survive the first cooking and develop into actively growing bacilli in the meat if it is left overnight; the new growth of organisms and toxins produced by them may not be destroyed by the cooking time and temperature needed merely to bake the pastry and warm through the meat. Great care should also be taken over the gelatin which is poured into the pie after it is cooked. It should be boiled and filled into the pies hot (150°F.) the pies should then be cooled rapidly and maintained in the cold until required.

### **Examples of outbreaks caused by anaerobic sporing bacilli and other organisms**

Some of the organisms suspected to cause food poisoning belong to a group which is less generally accepted and less well defined than is the case with staphylococci and salmonella. The symptoms produced when food is contaminated with these organisms may be due to toxins or infection, or to some other cause. Two outbreaks due to this "indeterminate" group of organisms are described.

The danger from meat contaminated with actively growing *Cl. welchii*, an anaerobic sporing bacillus, has already been mentioned. The following incidents illustrate the sequence of events which usually lead to *Cl. welchii* food poisoning. They occurred in the same school canteen, one almost a year after the other.

#### **The school canteen outbreaks**

The Medical Officer of Health reported an outbreak of abdominal pain and diarrhoea amongst a large number of children in a school served by its own canteen. The kitchen was visited the day after the outbreak occurred. The suspected meal, eaten 9 to 12 hours before the symptoms started, consisted of cold boiled salt beef, salad, and boiled potatoes, followed by a steamed pudding and jam. The meal was eaten without complaint and had tasted good. The beef had been delivered to the kitchen on the previous afternoon in joints weighing 4 to 6 lb. each. These joints were immediately cooked for 2 hours in large boilers of the type commonly found in modern school canteens. They were left in the open boilers all night to cool. The following day they were taken from the liquor, allowed to drain and cut up cold for lunch. A portion of this meat which had been left over and stored in the refrigerator was examined at the laboratory. Several types of bacteria were found, including the sporing



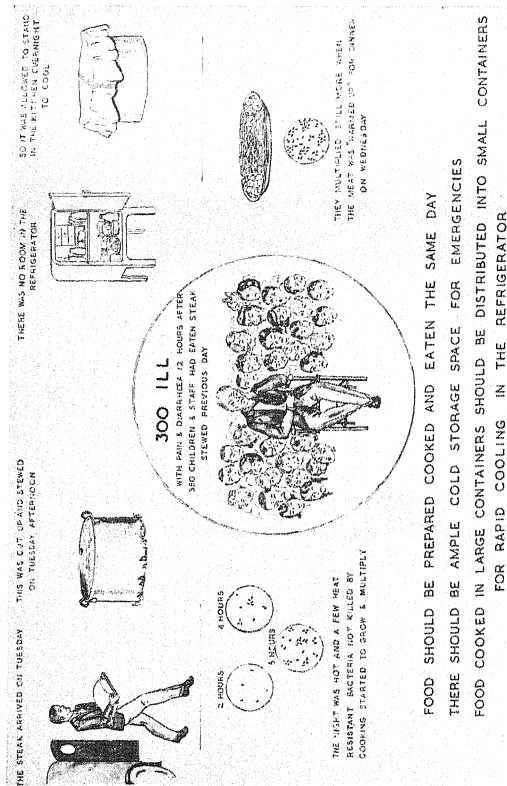


Fig. 14 Outbreak of *Clostridium welchii* food poisoning in a school canteen

organism *Cl. welchii*. It is assumed that either the spores had survived the preliminary heat-treatment or that airborne contamination had occurred after cooling, and that multiplication had continued vigorously overnight. The kitchen staff were warned that the procedure they had used—that of boiling the meat the day before it was required and allowing it to cool slowly overnight in the kitchen—was the most likely explanation for the outbreak. The staff appeared to understand, and agreed that it should not occur again.

Almost exactly a year later, the Medical Officer of Health reported a similar occurrence in the same school, affecting about 200 children. In the meantime it had been proved in the laboratory that the spores of a certain type of *Cl. welchii*, which had been isolated from many samples of meatstuffs suspected of causing outbreaks of diarrhoea and pain, were able to withstand several hours' boiling. The story told by the canteen workers of the sequence of events before the outbreak was similar to that of many other such incidents already reported. For the greater part of the year following the warning given after the first outbreak the staff had carried out the recommendations to cook and eat their meat on the same day, otherwise they had been careful to refrigerate overnight any meat they had cooked one day and intended to eat the next. For the past few months, however, they had relapsed into their old habits. On this occasion, rolled joints of salt beef for boiling had been cooked during the afternoon of the day before they were required. They were taken out of the boiler, put on to enamel dishes, and placed in the larder overnight, covered with cloths. They were sliced and eaten cold for lunch the next day. In spite of the fact that it was mid-winter, the cooling rate inside the rolls of meat must have been very slow, and an almost pure culture of heat-resistant *Cl. welchii* was found in the sample of meat examined. A similar organism was recovered from the faeces of all patients who submitted samples.

Whether the sporing bacilli were already present on the meat when it reached the canteen, or whether they were implanted on the meat by the hands of food-handlers who carried the germ in the intestine, it is difficult to say. Whatever the answer, however, if the organisms had not been given the opportunity to multiply, the food poisoning would not have occurred.

Anaerobic spore-bearing bacilli have been reported as the causative organism in a few outbreaks of food poisoning occurring in 1943, 1944, and in the United States of America in 1945. In 1943, gravy

prepared in bulk at a central school meals kitchen was distributed to surrounding schools, after it had stood in a large container in the refrigerator overnight. Several outbreaks of food poisoning occurred amongst children in neighbouring schools, and the gravy was found to be heavily contaminated with sporing organisms. The amount of fluid contained in a single bowl was large and even after refrigeration overnight the temperature in the centre of the mass was such that the multiplication of micro-organisms could easily have occurred.

### **The contaminated chocolate blancmange pudding**

Another outbreak caused by a different type of organism, the  $\alpha$ -haemolytic streptococcus, was due to faulty storage overnight of chocolate blancmange pudding. Several schools in a South Devon town were supplied with midday meals from a central school meals kitchen, and on one occasion hundreds of children were taken ill. The chocolate blancmange pudding had been eaten by all those who were sick. It was discovered that the pudding had been prepared the day before it was required, a usual practice, for blancmange must be eaten cold. The preparation of blancmange involves thorough heat-treatment of the milk, which is raised to boiling point before the blancmange powder mixed with water is added. It may be assumed that such a mixture would be practically sterile, and that it would remain so if transferred to small containers, cooled quickly immediately after cooking, and refrigerated overnight. Inevitably, however, there was a shortage of refrigerator space, and the blancmange was poured into the actual food containers to be used for distribution to the schools the following day; the filled containers were allowed to remain in the kitchen overnight. Whether it was thought that the blancmange would cool down satisfactorily this way, or whether it was the intention to keep it warm, it is impossible to say. In fact, the insulated containers acted as incubators, and maintained a suitable temperature for the growth of the streptococcus, which may have been introduced from the nose or throat of one of the workers, or from the containers if they had not been thoroughly cleaned and sterilized.

Some of the pudding which remained from the meal was examined in the laboratory. It was found to contain many millions of streptococci per gram. Although harmless in small numbers, when allowed to multiply vigorously in a suitable foodstuff, these organisms produce a toxic substance which, in this instance, upset numerous school

children. The busy and exacting work of a school meals kitchen rarely leads to disaster of this kind, and no doubt the outbreak would not have occurred had the workers been aware of the danger. Foodstuffs so susceptible to bacterial growth should not be stored at a temperature ideal for the multiplication of bacteria. It is hoped that such errors will cease as knowledge of personal and kitchen hygiene spreads amongst food-handlers.

### **The meat pie outbreak**

An outbreak affecting about 1,000 persons occurred recently from the consumption of meat pies contaminated with salmonella. The incubation period varied from 6 to 56 hours although the majority of cases developed symptoms within 12 to 24 hours.

The symptoms were moderately severe, in most cases lasting from 5 to 7 days; in a small number of cases, however, they were very severe and there were three fatal cases in persons aged 39, 63 and 72 years.

The salmonella organism responsible was isolated from stool and vomit of affected persons, from a dog and from many meat pies; a woman member of the staff at the bakery concerned was found to be a symptomless carrier of the same organism. Many employees had been taken ill after eating the pies.

The investigation included examination of all sources of meat and gelatin, as well as swabs from working surfaces, utensils, equipment and refrigerators; cats, mice, cockroaches and flies were also examined. These have all proved to be negative and the search for paths of spread of infection continues.

Figs 11-14 have been made from large diagrams designed for teaching and demonstration purposes.

## CHAPTER VII

### FOOD-BORNE INFECTION

There are many diseases spread by food which are distinguishable from the acute bacterial food poisoning described in the previous chapters. Dysentery and enteric fever—typhoid and paratyphoid fever—may be food-borne, and there are certain other infections which may be spread by raw milk, such as diphtheria, scarlet fever, tuberculosis and undulant fever.

Dysentery and typhoid bacilli are suspected to be infective in very small doses, that is, small numbers of bacteria from the surface of fruit, lettuce, watercress and cut slices of bread may be sufficient to cause infection and illness.

The incubation period for dysentery is from 2 to 4 days and the symptoms of acute diarrhoea may persist for several days.

The clinical picture for typhoid fever is quite different and the incubation period may be up to 3 weeks, which complicates the task of tracing the agent of infection. The illness begins insidiously with general malaise and fever. Intestinal symptoms may not be prominent until the second or third week of fever.

Paratyphoid fever is a summer disease and may resemble salmonella food poisoning, although the incubation period is longer—7 to 10 days—and there is usually a period of prolonged fever.

#### **Milk-borne infection**

Milk is an ideal medium for the growth of bacteria, and chances of contamination are numerous. It may be already dangerously contaminated when taken from the cow; tubercle bacilli are often excreted in the milk of a tuberculous animal. In Britain there are still 4,000 or more new cases of tuberculosis yearly due to the bovine tubercle bacillus. Also *Brucella abortus*, the bacillus responsible for abortion in cows, may be excreted in milk and give to those who drink it an infection known as undulant fever. This disease is not fatal but may be the cause of ill health over long periods of time. From mastitis of the udder or abrasions of the teats food-poisoning staphylococci and haemolytic streptococci, the infective agent for tonsillitis and scarlet fever, may be excreted in the milk. There have been widespread outbreaks of scarlet fever and tonsillitis caused by the growth in milk of streptococci from the throat of a milker with an acute sore

throat. Diphtheria bacilli from an infected throat may contaminate milk. In fact the nose, throat and hands of the milkers are potential sources of danger. Outbreaks of dysentery, typhoid and paratyphoid fever, and of salmonella food poisoning have been spread by milk initially contaminated by carriers amongst milkers or other persons engaged in handling the raw milk.

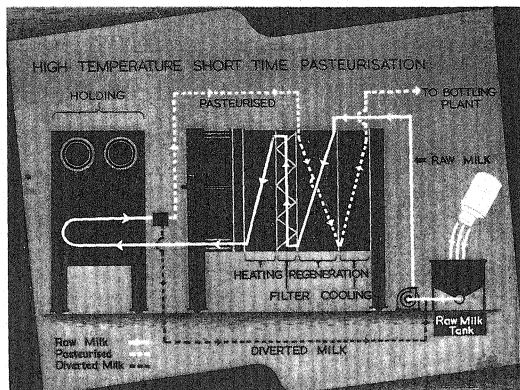


FIG. 15 Diagram of pasteurization plant ("High Temperature Short Time method")

The pails, milking machines and other apparatus may be washed with water polluted with human or animal sewage.

The cows themselves may suffer from salmonella infection, when faecal contamination of the milk may occur. Even the milk bottles, unless carefully washed and rinsed in hot water, may contain harmful organisms.

The only precaution against all these hazards to milk is that of pasteurization immediately before or after the milk has been bottled and capped. By this means all pathogenic organisms introduced from the cow, from subsequent contacts or other sources will be destroyed by heat; there will be no further danger of contamination until the bottled milk reaches the consumer's kitchen. Here, the milk is again subject to contamination but there are many ways in which it can be stored safely in the cold.

In England and Wales at the present time 81 per cent of the milk consumed is heat-treated either by pasteurization or by sterilization. The percentage of heat-treated milk is far higher in London and other large cities than in rural districts.

If the death rate from abdominal tuberculosis of children under five years of age is regarded as a reliable index of the incidence of bovine tuberculosis then the following figures are of interest. By 1944 the death rate per million children had fallen in rural districts to about a quarter of the 1921 figure (282 to 60), in urban districts to one-ninth (366 to 42), in county boroughs to one-twelfth (437 to 35), and in London to one-twenty-third (136 to 6). These figures probably correspond roughly to the increase in the heat-treatment of milk during these years. It is most significant that in London in 1944 the death rate was only one-tenth of that in rural districts in spite of the fact that a high proportion of bulked raw milk entering London is known to be infected with the tubercle bacillus. A recent report from Northern Ireland states that there has been a marked decline in the extent of the bovine-type infection during the last ten years. This is believed to be due to a great increase in the pasteurization of milk during this period.

Unfortunately we still hear stories of children who, when visiting the country, are given every day, perhaps at their parents' request, the milk straight from one particular cow. By an unfortunate coincidence they may choose a tuberculous animal and shortly succumb to the tubercle bacilli in the milk.

A few examples are given of food-borne and milk-borne outbreaks of infectious disease.

### **The pease pudding outbreak of dysentery**

It was customary in a certain little provision store to prepare pease pudding one day each week. On a certain occasion several people in the vicinity of the shop were taken ill with dysentery, and inquiries revealed that they had all eaten pease pudding prepared at the little shop. Suspicions were confirmed when remains of the pudding collected from the shop were shown to contain dysentery bacilli. It was some time, however, before the investigators were able to find out from whom these dangerous bacilli had come, and by what means they had been introduced into the pudding. Gradually the story was pieced together. On the day that the pudding was made two visitors came to the shop, a nursemaid and her charge, a little girl three to four years of age. The nurse was a friend of a young girl who worked in the kitchen and, as was her habit, she went into the kitchen to talk to

her, taking the child with her. While the two girls chatted together the child grew bored and wandered round the kitchen. Suddenly she noticed the pease pudding on the table and, deciding that it looked good to eat, she seized a handful and crammed it into her mouth. The hole in the pudding and the evidence on the child's face were vividly remembered by both the nurse and her friend. The child had recently recovered from an attack of diarrhoea which had been caused by the same dysentery bacillus as that responsible for the outbreak. The organisms were still present in her stools and must, on that occasion, have been present on her hands also, and by this means the bacilli were transferred to the pudding.

The thorough investigation of an outbreak of food poisoning may involve, therefore, not only a knowledge of the habits and illnesses of those actually employed as food-handlers, but of their visitors also.

### **Paratyphoid fever at a holiday resort**

At a North Devon holiday resort, cases of paratyphoid fever occurred occasionally from year to year amongst holiday makers who visited the long sandy beach. As most of them had bathed at one particular end of the beach it was assumed that paratyphoid bacilli discharging into the sea from the main sewer at a point not far from the bathers were responsible. The bacteriologist who had been in charge of the investigation was not happy with this explanation and decided to find out the true source of the organisms. He suspended cotton-wool swabs attached to suitable lengths of string at various points in the main sewer, its tributaries, and finally in the sewage waste from individual houses. When he examined these swabs in the laboratory, he found that one house only was responsible for the discharge of the infecting organisms, and that in this house lived a local ice-cream manufacturer and his wife. Specimens of stool were examined from each of them and it was revealed that, although the ice-cream manufacturer himself was clear, his wife was a carrier. Their ice-cream barrow was often to be seen on the bathing beach, and it is more than likely, therefore, that small doses of paratyphoid bacilli in ice-cream from the hands of the vendor or his wife were responsible for the outbreaks of paratyphoid fever rather than the presence of paratyphoid bacilli in the sewage which discharged into the sea.

### **Widespread paratyphoid fever spread by synthetic cream**

An extensive outbreak of paratyphoid fever occurred in the Midlands of England. There were 466 cases and although the ultimate origin was uncertain the most likely medium for the spread of



illness was suspected to be contaminated synthetic cream. The contamination was thought to be due to the unfortunate coincidence of one or more persons, infected in the early days of the epidemic, being employed in a large bakery where conditions were far from hygienic. Eight or more other persons employed in the same place were soon infected and it is likely that they contributed to the final result. The confectionery from the bakery was distributed over a wide area and the cases showed a similar scatter.

The results of investigation showed the importance of the bacterial examination of even mild intestinal disturbances and of the search for carriers and ambulant cases in the environment of sporadic cases of enteric fever.

It was also clear that the hygiene of the large bakery required careful supervision. And this was not an isolated example of the spread of infection from such an establishment.

### **Typhoid fever from raw milk**

An extensive outbreak of milk-borne disease occurred one autumn in a County Borough of Southern England.

There were 518 cases amongst the local inhabitants and about 200 persons were infected while on holiday in the district, although the disease did not develop until they returned home. The patients were scattered widely throughout three towns; men, women and children of all ages and occupation were affected. This suggested infection by a common food of wide distribution—milk was an obvious possibility.

It was soon discovered that all the primary cases had consumed raw milk from one particular firm. Immediately, steps were taken to pasteurize the supply to kill the infecting organisms before they were able to reach more victims.

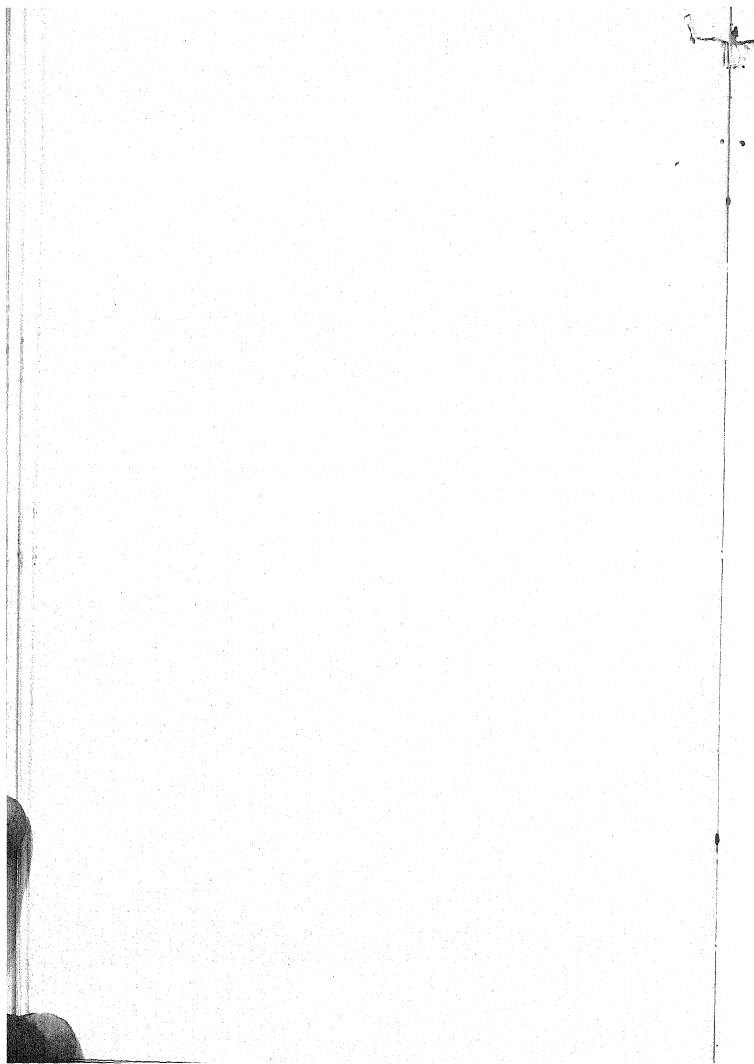
A search for the carrier among the employees of the firm, including the twelve roundsmen, was unsuccessful. Investigations spread to the thirty-seven farms that produced the milk to be mixed and distributed by the firm under suspicion. At one farm the housewife was ill with enteric fever, she died and her son developed the disease. This farm contributed 20 gallons of milk each day to the mixed supply of the retailer. The milking conditions were primitive and it was probable that this batch of milk, contaminated with typhoid bacilli, was responsible for the outbreak. Yet there was another puzzling feature in that a number of people had been infected before the farmer's wife became ill.

Further inquiries revealed the fact that, some years ago, a fatal

case of typhoid fever had occurred in a house adjoining the farm. The water supply was common to both houses and to eight others in the vicinity. It came from a deep well situated about 100 yards from a small stream. This stream was liable to pollution from storm water and the sewage effluent from a large house. Typhoid bacilli were found in the effluent and their origin was traced to a carrier in the house.

It was next demonstrated, by chemical means, that there was a connection between the stream water and the well. Furthermore the farmer's cows and those of another producer who also contributed to the same dealer's milk supply used pastures alongside the stream. They drank from the stream and perhaps while standing in it their udders were washed by the contaminated water.

The exact mechanism of the transfer of infection was considered to be water-borne in the first instance but the main outbreak was due to the consumption of raw mixed milk.



## PART II

### *Food Hygiene in the Prevention of Food Poisoning*

#### CHAPTER VIII

#### INTRODUCTION

So far we have dealt with the bacterial causes of food poisoning, the reservoirs of the infecting germs, and the conditions under which they grow and multiply into numbers dangerous to the health of those who eat them.

Some of the means by which foodstuffs can be protected from gross contamination will have become obvious but others may not be quite so clear. The immediate application of methods to raise the standard of hygiene may seem, in some instances, to be impracticable at present, yet they must be discussed in the light of plans for the design of future establishments for the preparation and service of food and for the training of food-handlers.

In answer to the question "What can we do to prevent food poisoning?" there are seven general points which stand out and which should be impressed on the mind of every food-handler; such a list might be placed in every kitchen engaged in the bulk handling of food:

- (a) Wash hands frequently and particularly after visiting the toilet and before handling food.
- (b) Do not touch food with hands more than is absolutely necessary.
- (c) Cover cuts, burns and other raw surfaces with waterproof dressings while handling food.
- (d) Keep food cold during storage, particularly cooked meat dishes, gravies and trifles.
- (e) Cook thoroughly all foods known to harbour food-poisoning germs, such as meat, ducks' eggs and dried egg.
- (f) Protect food from flies, rats, mice and other pests.
- (g) Clean all food and drink utensils in a good detergent and rinse in nearly boiling water.

Of these it is considered that two are far more important than the rest.

First, cleanliness and care of the hands. It is only by vigilant

attention and constant care that the habits of personal hygiene of food-handlers may be such that bacteria carried on or in them may be kept out of the food they prepare or serve. Yet with whatever care the food-handler regards his work germs may enter food in numerous ways.

The second most important consideration, therefore, is food storage. Not only should foodstuffs be protected against the contamination of human, animal or insect vectors of bacteria, but conditions of storage should ensure that they can be maintained at the correct temperature for inhibiting the growth and multiplication of these germs. Most human beings are able to resist the attack of small numbers of bacteria; a few organisms from the hands or sneeze of the food-handler or from the feet of a fly will be dealt with by the resistance of the individual. When, however, these numbers have multiplied to many millions, the resistance of the human body is swamped and the infecting bacteria may conquer with disastrous results. The ever-present danger of contamination should be in the minds of all those engaged in work with food; they should know how best to store foods susceptible to bacterial growth, so that there may be no increase in the number of bacteria already present.

To enable food-handlers to apply these principles to their work it is necessary to give them the facilities to do so. It is impossible to expect perfect food hygiene under bad conditions. There are too many small ill-designed kitchens constructed of materials which are difficult to keep clean and equipped with apparatus which cannot be sterilized, while cold storage accommodation may be absent or quite inadequate.

There are kitchens, sometimes below street-level, which provide such appalling working conditions that the food-handlers lose heart in the everlasting struggle to produce far more meals than is convenient for the size of the kitchen. Under these uncomfortable conditions it is impossible to apply principles of good food hygiene.

In one of these basement kitchens seen recently, the staff appeared hot, harassed and tired; the walls and ceiling were begrimed and in need of repair; there was little free space for movement and less for storage. There were flies everywhere and the tea-cloths were hung on a line in the toilet which opened directly on to the kitchen, thus contravening the Regulations laid down in the Food and Drugs Act, 1939. There seemed little incentive or opportunity to keep a high standard of cleanliness in surroundings such as these. Shortly after this visit a newly built kitchen serving a small café was visited. It presented a striking contrast. The walls and floor were tiled, it was light and well ventilated. The table-tops, sinks and draining-boards

were of stainless steel and everything was clean and shining. This kitchen gave incentive to cleanliness, and the food-handlers, grateful for their surroundings, responded by keeping themselves and their kitchen spotlessly clean and free from the chance of infection.

The aim of the following chapters is to emphasize the most important factors in the prevention of food poisoning as they have been recognized while studying the spread of infection both in the field and in the laboratory. There are other factors, sometimes magnified in the public mind, which may be relatively unimportant in themselves and which may serve merely as an indication that the conditions in a particular establishment are not all that may be desired. The presence of lipstick on a cup is not necessarily a sign that dangerous germs must be present also, but that the washing-up has not been carried out with due care and attention. Varnish on the nails of a waitress or kitchen employee is not in itself a harbour for bacteria, but perhaps an indication that the hands will not be washed nor the nails scrubbed as often as desirable, for fear of damaging the cosmetic effect. The flakes of whitewash which may descend from the ceiling into food during its preparation may not constitute an immediate danger, but indicate that the general care of the kitchen is poor. A hair in the soup should not arouse immediate alarm but it indicates careless habits and lack of attention to detail which may provide disastrous results on other occasions. The unwrapped loaf dropped on the road or carried in the crook of a baker's arm will not give rise to food poisoning or even food-borne infection except in exceptional circumstances, yet it indicates a lack of care and respect for the food which others have to eat.

There are many such examples which arouse feelings of disgust in the minds of people who have never been taught to realize the significance of their own bad habits of nose picking, finger licking, coughing, sneezing and failure to wash the hands after visits to the toilet.

It is with these thoughts in mind that the succeeding chapters on prevention deal respectively with the food-handler, the food itself, utensils and the kitchen and lastly the part the Food Trader can play in the prevention of food poisoning.

## CHAPTER IX

### PERSONAL HYGIENE OF THE FOOD-HANDLER

With a growing knowledge of the habits of bacteria we can learn how to cut the chain of events which links the germ carrier to the food and the contaminated food to the unsuspecting victim. Every food-handler has a part to play in improving his or her observance of the rules of hygiene, so that the links in the chain of infection may be broken.

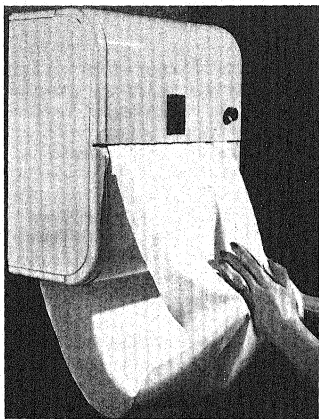


FIG. 16 Continuous roller towel



FIG. 17 Hot air drier

#### Care of the hands

The first and most important rule for personal hygiene is to keep the hands clean, so that as far as possible our own personal bacteria are washed away from our hands and thereby kept out of other people's food.

To encourage frequent hand washing before and during the preparation and serving of food—and incidentally before the eating of food—there should be sufficient and convenient wash-hand basins

not only in or immediately outside the toilet but also in the kitchen. The kitchen sink is a poor substitute for a wash-hand basin, for it is used for many things including dish-washing and the cleaning of fruit and vegetables. It may be full of dishes, pots and pans, lettuce or potatoes at a moment when a member of the staff has returned from



FIG. 18 Hygienic method of slicing meat

the toilet or has used a handkerchief and wishes to wash away any contaminating germs from the hands.

Bacteria can linger in sinks, particularly those made of wood; intestinal bacteria have been recovered from teak sinks after thorough washing and scrubbing with soda solution. Similarly intestinal bacteria from the hands can cling to utensils and containers, lettuce, and other things which may be washed in the sink.

Nails should be kept short and scrupulously clean. Dysentery bacilli and other pathogenic organisms have been isolated from swabs rubbed under the nails, particularly from those workers whose standards of personal hygiene are low.

The hands should be washed with plenty of soap in warm water



using the minimum of water to make a strong soap solution; they should be rinsed in running water. For drying the hands individual towels should be used for each person; these may be paper, or cloth provided they are changed often enough, each employee hanging his or her own towel on a hook by the wash-basin. The "continuous" roller-towel system which provides a portion of clean towel for each person is to be recommended. An electric hot air drier can be efficient and pleasant to use. Communal roller towels should not be

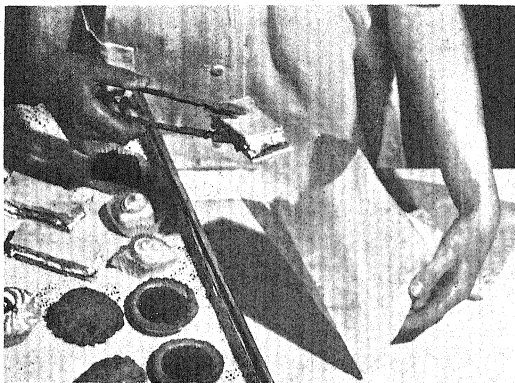


FIG. 19. Pastry tongs

encouraged, for they have been known to transfer infection from one person to another. It is almost impossible even in the smallest establishment to ensure that the hands are dried on a previously unsoiled portion except by making extravagant demands on the laundering services.

The skin of the hands must be kept not only clean but soft and healthy and it is necessary, particularly in cold weather, to use a hand lotion to keep the skin free from cracks and harshness. A simple and inexpensive hand lotion may be made from gum tragacanth and glycerin in the proportion of one part of tragacanth to two parts of glycerin in water with the addition of a few drops each of the oils of lemon and lavender. There are also commercially produced hand creams which are both effective and economical.



(a)



(b)

FIG. 20 (a) Bad bandaging. (b) Good waterproof covering for burns and cuts

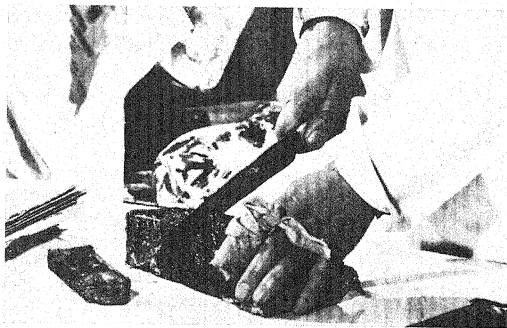


FIG. 21 Hand with septic finger holding corned beef

In spite of all precautions, however, it is not always possible to rid the hands of staphylococci; these organisms may live habitually in the sweat glands and hair follicles of the skin, and to eliminate them may require drastic treatment with antiseptics.

The next important point, therefore, is to remember that food should not be touched with the bare hands more than is absolutely necessary. There is far too much handling of susceptible foodstuffs not only in kitchens but in the retail shop and factory. It should be

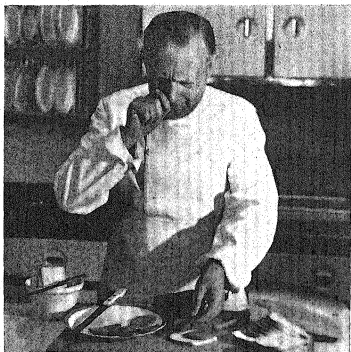


FIG. 22 Habits to avoid—fingering the nose while preparing sandwiches

possible to have implements to carry out the work of the fingers, particularly for meat and confectionery that are not to be cooked subsequently.

Cakes decorated with synthetic cream should not be touched by hand. In some countries where the practice of food hygiene is far advanced, even the smallest village shops are equipped with plastic or metal tongs so that the fingers need not come in contact with small cakes. It may take longer to use an instrument than fingers for managing foodstuffs, but when the health of people, and even a life may be at stake, the extra time is well spent.

The third point to remember about the hygiene of the hands is that cuts, burns and other raw surfaces, however small, should be covered as soon as possible with waterproof dressings while work with food is continued. Even the small abrasion which looks healthy may

harbour many staphylococci, and a cotton bandage is no protection against germs passing out in serous fluid from the lesion or in from the environment. Where a lesion on a hand is obviously infected, that hand should not be allowed to touch susceptible foodstuffs until the lesion has healed.



FIG. 23 A neat and effective head covering

### Habits

There are certain bad habits which should be avoided by the food-handler. The unguarded cough or sneeze can disperse from the nose, mouth or throat large numbers of bacteria suspended in droplets of moisture. These droplets may fall on to foodstuffs in the vicinity and they also serve to pass infection directly from one person to another.

Another dangerous habit is that of licking the fingers to pick up paper or to turn over the pages of a book. This is a bad habit at any time but it is unpardonable when the paper, contaminated with saliva, is to be used for wrapping food.

Nose picking or fingering the nose may leave staphylococci or other harmful organisms on the fingers. Clean handkerchiefs are almost free from bacteria, but dirty ones may harbour millions; if the

handkerchiefs are shaken, the attached bacteria can readily escape into the air or on to the foods.

Nail varnish, although not itself harmful, may deter the wearer from keeping her nails short and well scrubbed.

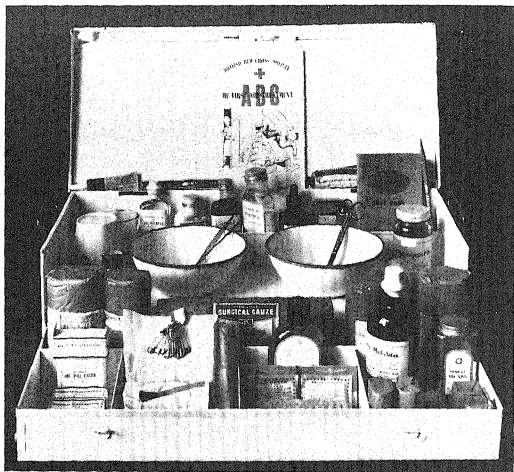


FIG. 24 First-aid box

The hair should be clean and kept neatly by means of a cap or other head covering; a net will effectively keep the hair in place (Fig. 23).

Smoking while on duty should be avoided; the smoke and ash of a cigarette are harmless, but many smokers contaminate their fingers with saliva while taking the cigarette from their lips or when removing loose pieces of tobacco from the mouth. Any such habit which may result in the contamination of the fingers should be stopped.

The common practice among waitresses of using a cloth carried in their belts or over or under the arm, for a variety of purposes should be discouraged. At one table, crumbs and cigarette ash are swept away, at another, spilled water is mopped up, and at a third, some

utensil or glass is polished with the same cloth, which may be grossly contaminated with many bacteria.

Forks, spoons, cups and glasses should be handled correctly by keeping the fingers from those parts which are touched by food and mouth.

It should be a maxim, therefore, that all food-handlers, waitresses, and those concerned with food should have clean hands, clean tidy hair, and clean clothing. They should be scrupulously careful that mouth, nose and bowel organisms, through saliva, nasal and other discharges, be kept out of the food they handle. They may be encouraged to be smart in their attire so long as their dress and shoes are sensible and well fitting; slovenly attire is often an indication of general carelessness. Illnesses, however mild, should be reported at once, particularly those accompanied by vomiting, diarrhoea, sore throat, cold, or skin infection. The smallest abrasion should be treated with care and covered with waterproof dressing.

Most large shops, stores, and factories possess a well-equipped medical department including a surgery and waiting-room. Small shops and kitchens should possess a first-aid box and keep at least one member of the staff up to date in first-aid treatment. All large establishments should be provided with adequate changing-rooms, rest rooms, and facilities for storing clothes and other personal belongings.

Education on good standards of health and hygiene for all those working with food should be provided by the medical officer, sanitary inspector, welfare nurse or other responsible person. Regular educational talks on personal hygiene should be encouraged, for the first essential to food hygiene and the elimination of food poisoning is the standard of living of those who prepare and serve food.

## CHAPTER X

### FOOD STORAGE AND PREPARATION

The part to be played by the food-handler in preventing the contamination of food has already been discussed; the next most important factor is the storage of foodstuffs. By the use of correct methods of storage the multiplication of organisms and also the production of their toxic substances can be controlled.

#### Cold storage

The effect of cold on micro-organisms depends on the intensity of the cold. When foods are "chilled" or stored at temperatures near freezing-point, bacteria will grow slowly; but in the frozen or solid state, although they may not be killed directly, they do not multiply and consequently become fewer as many may die of old age. Hence freezing preserves for a long time those foods which are not spoiled by being frozen, while chilling merely delays decomposition for a week or so. In the refrigeration trade the term "chilling" is used to cover any reduction in the normal temperature of the article concerned. For example, to delay the ripening of tropical fruits during transit a temperature not far below that of the atmosphere is used. Whereas to delay the decomposition of imported meat, storage during transit is carried out at  $-3^{\circ}$  to  $-1^{\circ}\text{C}$ . ( $28^{\circ}$  to  $30^{\circ}\text{F}$ .).

As the temperature falls bacterial activity declines, so that spoilage is reduced and there is longer life for the foodstuff; it is, therefore, worth while storing many foodstuffs at a temperature as near freezing as possible. Some foods cannot be kept chilled at too low a temperature because there may be harmful changes in the food itself; for instance, apples go brown internally if chilled below  $3.5^{\circ}\text{C}$ . ( $38^{\circ}\text{F}$ .) and the resistance of some fruits to moulds may be destroyed by chilling, so that the rate of rotting by moulds is increased.

With regard to pathogenic organisms, some strains of salmonella will develop at  $10^{\circ}\text{C}$ . ( $50^{\circ}\text{F}$ .) but not at  $5^{\circ}\text{C}$ . ( $41^{\circ}\text{F}$ .); and staphylococci will not grow below about  $10^{\circ}\text{C}$ . ( $50^{\circ}\text{F}$ .), although they not only grow at  $20^{\circ}\text{C}$ . ( $68^{\circ}\text{F}$ .) but form toxin. The sporing anaerobic organism, *Clostridium botulinum*, will grow very slowly at  $10^{\circ}\text{C}$ . and in some instances toxin may be formed at this temperature but there is no growth or toxin formation at  $5^{\circ}\text{C}$ . ( $41^{\circ}\text{F}$ .).

Some bacteria are able to increase slowly at cool temperatures; for example, milk stored too long in a refrigerator may be gradually spoiled by such bacteria instead of being soured by the usual organisms which grow at normal temperatures.

The freezing of foodstuffs results in the immediate death of many of the organisms present, and the rate of death of the remainder depends on the temperature of storage. Of the well-known food-poisoning organisms, those of the salmonella group disappear most rapidly. In strawberries kept at  $-18^{\circ}\text{C}$ . ( $0^{\circ}\text{F}$ .) it has been reported that salmonella organisms disappear in one month and staphylococci in five months. The spores of *Clostridium botulinum* are not affected by freezing, and the highly poisonous toxin of this organism has considerable resistance against alternate freezing and thawing at as low a temperature as  $-50^{\circ}\text{C}$ . ( $-58^{\circ}\text{F}$ .). Staphylococcal enterotoxin is able to withstand a temperature of  $-4^{\circ}\text{C}$ . ( $24^{\circ}\text{F}$ .) for two months.

Moulds and yeasts survive freezing better than bacteria, and refrigerators should be thoroughly cleaned periodically to ensure freedom from them.

When highly contaminated foodstuffs are kept frozen it is believed that changes may occur in the food owing to the slow activity of surviving organisms over a long period of time. Furthermore, when thawed after a period of frozen storage the texture of foods is often damaged, so that they exude fluid; a food in this state is more favourable for bacterial growth than a fresh food.

It must be remembered, therefore, that although freezing destroys some of the bacteria and arrests indefinitely the development of others it will not restore the freshness of a food already highly contaminated or spoiled by bacterial action. If the food is not spoiled before freezing, it is believed that the presence of large numbers of bacteria may conceivably cause some spoilage during storage in the frozen state, though far less, of course, than the spoilage which would occur in the unfrozen food. When it is thawed, a certain number of bacteria will remain and decomposition will be restarted; among the surviving bacteria there may be food-poisoning types.

Every kitchen should possess ample cold-storage space and, where it is justified by the size of the canteen, there should be a cold room in addition to one or more household refrigerators.

There should be a well-defined air space between the kitchen and the refrigerated room, so that the hot air from the kitchen will not influence the temperature, which should be checked regularly by



means of a thermometer hung in a position where it can be read easily.

Cold rooms and household refrigerators for normal canteen work are usually maintained at temperatures between  $34^{\circ}$  and  $38^{\circ}$  F. ( $1^{\circ}$  to  $4^{\circ}$  C.); this is not low enough to freeze foods, and the low-temperature bacteria grow; hence the life of food in the refrigerator is limited, and the longer it remains there the shorter its life on removal. In large establishments it is advisable to keep more than one refrigerator. Suggested conditions for the temporary storage of various foodstuffs as recommended by the Ministry of Food are given at the end of the Chapter.

Refrigerators should be well ventilated, and cleaned and defrosted regularly; they should not be overcrowded. Many foodstuffs which are commonly stored in a refrigerator do not encourage bacterial growth, and they could with safety be kept for a few days in a cool room on a slate or stone slab; for example, the fats, such as lard, margarine and butter, and hard cheese, unopened tinned goods and cured bacon. Space in the refrigerator should be available for the much-handled cooked foods or other perishable foods which, if given the chance, will encourage bacterial growth.

Refrigerators are intended to keep food cold and not to cool hot food which will (*a*) choke the cooling coils and (*b*) cause condensation on adjacent cold foods, which greatly assist the growth of slime bacteria. Cooked foodstuffs should, therefore, be cooled rapidly before they are placed in the refrigerator; methods for quick cooling are considered on page 91.

The education of kitchen staff in matters of food hygiene should include instruction in the correct use of refrigerators. In particular they must be taught that the cleanliness and safety of a refrigerated foodstuff are dependent on the extent of bacterial contamination before refrigeration and also on the temperature of refrigeration; also that extreme cold merely delays the growth and multiplication of bacteria, which immediately renew their activity when the food is transferred to a warm room.

There are various improvised methods for keeping food cool in the home. These include earthenware vessels cooled with water for milk and butter. Another method for keeping milk cool is to cover the mouth of the bottle with a large square of muslin so that the four corners of the muslin dip into water surrounding the bottle. A small covered cupboard standing in water contained in a large basin or bath may be used for more bulky foods. There is no method, however, which will effectively replace the refrigerator.

In retail shops cold-storage space should be readily available for susceptible foods such as cooked meats and pies, which should not be stored for hours or perhaps days in the shop window; they should be kept cold until required for immediate sale.

### **Cooling rates**

Special apparatus should be provided for the rapid cooling of large bulks of solid cooked food, for example, pies and joints, to enable refrigeration to be undertaken as soon as possible. In some factory kitchens, for instance, there are wind-tunnels about five feet high, three feet wide and twenty feet long, provided with iron rails at different heights to support metal trays on which the food passes along to the outlet where there is a 60- to 80-inch diameter fan; in other establishments there are cupboards with descending cold air streams. It is obviously impracticable for small establishments to install mechanisms such as these. Even in small kitchens, however, it should be possible to use a simple circulating fan installed in a small well-ventilated "cool" room which will provide a fairly efficient system for quick cooling.

A cabinet with shelves to which is attached an electric fan and air filter referred to on page 24 of the Report of the Manufactured Meat Products Working Party, Ministry of Food, 1950, may provide a solution to the problem. The use of small joints in preference to large ones will improve the rate of cooling.

Stews, gravies and other liquid foods prepared in large bulk should be distributed into shallow containers to assist rapid cooling before refrigeration. An adjustment to the internal construction of household refrigerators might provide suitable space for the storage of a series of shallow trays one above the other.

### **Protective covers**

Covers of glass, perspex or other suitable material, of cellophane, and greaseproof paper, should be provided for cooked meat, sandwiches, and all susceptible food on sale, to avoid contamination from vermin, dust, etc. It is obvious that if the food is already contaminated a cover or wrapping will not prevent bacterial growth, which may even be encouraged by the increased surface humidity, if the wrapper is "moisture-proof".

The wrapping of bread has already been discussed in a previous chapter; it is desirable, but it is not an essential preventive measure

against food poisoning. Moulds grow well on bread, but except for the poisoning known as ergotism which is caused by a mould infection of grain, they do not give rise to gastro-enteritis.

It is gratifying to find in many of our large food stores ideal arrangements for keeping food covered while it is on sale to the public. It is good also to observe the improved way in which food is stored on many railway stations (Fig. 25). Sandwiches, pies, and cakes are wrapped in cellophane, or stand under glass covers or on shelves



FIG. 25 Covered display shelves

protected from the air on three sides. The little trolleys which are pushed around the railway platforms are covered in, and the food they carry is well protected with cellophane.

### Storage room

Rooms suitable for the storage of various foodstuffs should be available. In the main storage cupboard are kept the tinned goods, stacked on shelves; powdered foodstuffs such as sugar, flour, oatmeal, sago, and rice are kept in metal bins with close-fitting lids, which usually stand on the floor. Except for those in metal bins, foodstuffs should be stored at least 18 inches above the floor, and packed goods considerably higher, while all efforts should be made in the design of these rooms to discourage vermin, to keep them free from dust, and to make them easy to clean.

The cool room, or larder fitted with slate or other stone slabs for those foods which are not immediately susceptible to bacterial

contamination, but the keeping quality of which is better maintained in a cool temperature, has already been mentioned (page 90). During the winter months milk can be kept in the cool room, but in the summer it should be refrigerated, particularly when stored in churns; churns must be kept covered. The circulating fan to assist quick cooling in bulk foods might be installed in this room.

In many kitchens there is also a separate room for the storage and preparation of vegetables, so that dust and earth from potatoes, carrots, turnips and other root vegetables may be kept away from the main kitchen.

### **Cooking and food preparation**

The surest precaution against food poisoning is to cook food thoroughly and eat it at once while it is hot. This applies particularly to all foods suspected as being potential sources of food poisoning.

**Meat and fish dishes.** Heat penetrates slowly into joints and made-up dishes such as pies, and adequate cooking times and temperatures should be allowed for the centre to reach boiling point. For instance, a 6½ lb. meat pie requires a temperature of 350° to 400° F. for 2½ to 3 hours for the centre to reach boiling point at 212° F. An outbreak of food poisoning has already been described in which an organism of the salmonella group was isolated from several pies of two sizes: 1 lb. and 4 oz. The minced meat had been hand-filled raw into the pastry cases and the cooking, at 450° to 475° F. for 25 to 30 minutes, was evidently inadequate to destroy the contamination. It was pointed out that pies made with raw meat should be cooked to the point of sterility even though the pastry may become a little over-brown in the process. It is worth while to note that meat turns from red to a uniform grey and the meat juice becomes colourless at approximately 80° C. (176° F.).

Pre-cooked meat is often used for filling into pastry cases, so that the pies need to be cooked for a time sufficient only to bake the pastry. The temperature reached in the centre of these pies would not necessarily destroy sporing or even non-sporing organisms, which would multiply actively while the pie was still warm.

The common idea that it is better in hot weather to cook meat partly, in order to preserve it overnight, is not regarded favourably by the bacteriologist. "Part-cooking" will kill some bacteria, but it will allow others to survive; subsequently these heat-resistant organisms will multiply and perhaps form toxins. When the final cooking

is light it is probable that neither the bacteria nor their toxins will be destroyed.

It is safer to keep meat in the raw state overnight, preferably in the cold, and to cook it thoroughly on the day when it is required. If, from motives of economy or for some other reason, it is essential to cook meat the day before it is eaten, it should be cooked thoroughly, cooled rapidly, and refrigerated overnight. When there is insufficient refrigerator space, it should be a strict rule that all dishes of stewed or boiled meat, whether as stews, pies or joints, must be cooked and eaten the same day. The danger of eating cooked meat a day or two later seems to be far greater in the communal canteen than in the home, although in no instance should stewed or boiled meat be allowed to stand at a warm temperature for several hours.

Roasting temperatures are considerably higher than those used for boiling or steaming, and it is assumed that well-roasted joints are sterile when they leave the oven; unless they are contaminated by hand after cooking, they may be expected to remain free from pathogenic organisms.

The usual cause of food-poisoning outbreaks traced to cold roast meat is contamination of the meat after cooking. Moreover it is possible that heat-resistant spores may remain alive in the centre of a large rolled joint through which the penetration of heat has been inadequate.

The efficiency of the temperatures used for frying or grilling will depend on the time of cooking. The degree of heat reached inside a grilled or fried sausage will depend on the preference of the cook for a well-browned or lightly cooked article. Rissoles and fishcakes made with pre-cooked meat, or fish and potatoes, may be placed in the frying-pan or grilled for a few minutes only. Raw foods such as fish, meat and bacon are likely to be grilled or fried thoroughly on both sides in fat, which should ensure sterility.

The installation and use of pressure cookers for quick, high temperature cooking might solve many of the difficulties associated with the preparation of foodstuffs on the day they are required to be eaten hot.

**Milk foods.** The hazards associated with the preparation of food a day or so ahead of requirements applies also to custards, trifles, blancmange and other milk puddings; these dishes should be freshly cooked unless they can be stored in a refrigerator.

By heating (or cooking) milk gently, as in pasteurization, all organisms which are potentially dangerous are destroyed so that the milk

is made safe unless recontaminated in the home. The term "Sterilized milk" means that a temperature is reached at which bacteria are destroyed, and the milk will remain sterile for an indefinite period.

The susceptibility of certain confectionery creams to bacterial contamination has already been emphasized, and their preparation and storage should be considered with care.

**Infant feeds.** Careful precautions are necessary in the preparation and storage of bottle feeds for infants. A recent publication on the "Bacterial flora and bacterial counts of infants' bottle feeds" states that, "... the high count of certain feeds may have been due to bacterial growth occurring during the period of cooling and storage ...".

"Bacteria may be introduced into a feed by the constituents of the feed, the bottles, the teats, or the utensils used in preparation. . . ." The danger of preparing feeds in imperfectly sterilized utensils and of storage without refrigeration was clearly demonstrated.

The author states that "unless close attention to detail is given at every stage of preparation, unsafe feeds carrying pathogenic bacteria and unclean feeds carrying large numbers of non-pathogenic bacteria may result . . .". She goes on to describe the interest shown by the United States of America in the problem associated with hospital milk kitchens and the preparation of safe infant feeds. Hospitals and health authorities throughout America are adopting methods whereby feeds are heat-treated in bottles already filled.

It is true that much care, attention and legislation have been given to the hygiene of milk supplies, liquid and dried, for the general public, and similar care is needed to ensure a safe, clean product for the infant consumer.

**Other infant foods.** A common weaning food for infants is bone and vegetable broth either tinned or prepared in large quantities in the home. Guidance should be given to mothers on the preparation and storage of such foods which are excellent media for the growth of bacteria.

**Egg products.** Small numbers of organisms of the salmonella group may be present in spray-dried and unpasteurized frozen whole egg. It is recommended, therefore, that rehydrated powder and thawed liquid egg should be cooked within 2 hours of preparation, unless they are refrigerated in small amounts.

Such egg products should be used only in recipes for mixes which will receive thorough heat-treatment. It is worth while quoting here an outbreak of food poisoning which occurred in an army camp. Reconstituted mix was prepared early one morning, part of it was scrambled for breakfast and eaten by seventy men, only one of whom was affected. The portion which remained was allowed to stand in the cookhouse until tea-time, when it was scrambled lightly. By this time the original bacterial population of the dry powder had increased enormously. Unfortunately, amongst the harmless bacteria present were a small number of the harmful salmonella organisms, which had also multiplied vigorously, and the heat-treatment received in the cooking was insufficient to kill them, with the result that of the twenty men who ate the scramble for tea sixteen were taken ill.

Infection from contaminated ducks' eggs can be avoided by boiling them hard—for at least ten minutes—frying well on both sides or confining their use to baked products, such as cakes and puddings, which require temperatures of cooking high enough to destroy the organisms. Lightly cooked or uncooked dishes, such as scrambles, omelettes, meringues, mayonnaise, or similar foods, should not be made with ducks' eggs.

**Gelatin.** Powdered gelatin is another substance which requires particular care in preparation and addition to foodstuffs, because it may contain a large and varied flora of bacteria. Melted gelatin in water for use in cooked meat pies and also for other purposes such as for glazing meat loaves should be nearly boiled, and used as rapidly as possible with the temperature maintained above  $60^{\circ}\text{C}$ . ( $140^{\circ}\text{F}$ .). This procedure may involve the use of a higher concentration of gelatin than formerly needed at low temperatures to produce an effective gel.

The hygiene of food storage and preparation depends on a knowledge of the habits of bacteria, the foods they contaminate most frequently, and the temperatures they do and do not like for multiplication. When these facts are known, a common-sense view can be taken of the matter, so that the more susceptible foods can be protected against the potential danger of contamination with food-poisoning and spoilage bacteria.

#### **Suggested conditions for the temporary storage of foodstuffs**

*Perishable foods.* Certain perishable foods should be kept in a refrigerator maintained at a temperature of  $0^{\circ}$  to  $4.4^{\circ}\text{C}$  ( $32^{\circ}$  to  $40^{\circ}\text{F}$ .).

These foods include meat, rabbits, game, poultry, fish, shell eggs, milk, cream, fats, butter, lard and margarine. Fish, however, should if possible be kept separately as it readily taints other foods.

Frosted foods and frozen liquid egg should be kept frozen until required, a temperature of  $-20.6^{\circ}\text{C}$ . ( $-5^{\circ}\text{F}$ .) being suitable.

Fruit and vegetables should be kept in a cool and well-ventilated place protected from frost. Sacks of root vegetables should stand on duck boards to facilitate the circulation of air.

*Dried foods.* Dried foods including dried fruit, fish or meat should be kept in a cool dry place. It is important to avoid conditions which could lead to condensation of moisture on the surface.



## CHAPTER XI

### UTENSIL CLEANING AND STERILIZATION

In Chapter IV it was pointed out that food may become contaminated by contact with dirty food utensils, and also that pathogenic organisms may reside in food particles left on imperfectly washed crockery and utensils, thus providing a source of infection and contamination to those using them and to fresh foodstuffs. The word "dirty" applied to crockery and utensils implies not only the presence of visible dirt but also the invisible presence of thousands or even millions of bacteria. It is unsafe to use contaminated utensils and containers particularly for cooked foods not intended for immediate consumption.

Dish-washing is considered by some to be an unpleasant menial task, and the work is too often poorly paid. Its importance, however, warrants a great deal more attention both aesthetically, for the appetizing appearance of food is not improved if accompanied by half the last user's meal, and to safeguard health.

The methods in general use for cleaning cooking and eating utensils may be divided into two groups; hand-washing and machine-washing. Both these systems should start with the removal of left-over food, followed by a preliminary wash under running hot water, which helps to preserve the cleanliness of the wash water.

#### **Hand dish-washing**

The laboratory examination of crockery and cutlery washed in one sink or bowl and immediately wiped without rinsing has shown that large numbers of bacteria are still present. When a final rinse is given, either in a bowl of water distinct from the wash water or by means of running hot water, the results are much improved and the articles may be almost sterile. Running hot water supplied by a boiler system or a water heater is not always available, but a bowl of hot rinse water is practicable for everyone.

#### **Two-sink system**

When two sinks are provided, the first should be used for washing with water as hot as the hands can bear— $43.3^{\circ}$  to  $48.9^{\circ}$  C. ( $110^{\circ}$  to  $120^{\circ}$  F.)—containing a cleansing agent. The most common one in use,

but not the most efficient, is soda (see also page 108). The second sink should be used for rinsing with very hot water. The temperature will depend on whether the hands must be used or whether long-handled racks or wire trays are available.

The simplest and most effective method of producing germ-free crockery and utensils is with a two-sink system which provides, after washing in a good detergent, a final rinse water of 77° to 82°C.

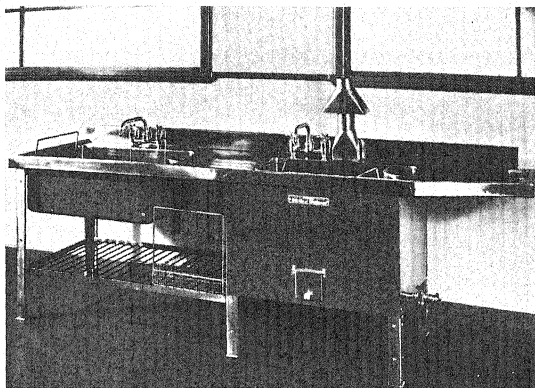


FIG. 26 Two-sink unit with sterilizing sink

(170° to 180°F.). For this purpose a metal rinse sink of galvanized iron or stainless steel may be used. These sinks are heated by steam, gas or electricity, and the heating mechanism is thermostatically controlled at about 82°C. (180°F.). A thermometer should be placed in an obvious position on the sink, so that the staff will have no difficulty in judging the correct temperature. Such units require little space and are relatively inexpensive; they are becoming increasingly popular and may be seen in many school canteen kitchens, as well as in the kitchens of catering firms.

The use of a really hot rinse serves not only to rid the plates of wash water, cleaning agents, and bacteria, but also it allows plates, cups and glasses to drain and dry quickly without the use of drying cloths, which may serve to recontaminate the articles with bacteria. Wash

and rinse waters should not be used when they have cooled, for lukewarm water will encourage the survival and multiplication of bacteria introduced from food particles. Drying cloths used to wipe a series of articles from such waters, unless they are constantly changed, will be teeming with bacteria—sometimes of intestinal origin. Laboratory experiments have proved that bacteria introduced from a contaminated drying cloth may be passed from plate to plate. A carrier of food-poisoning or enteric organisms could, theoretically, leave such germs on plates or utensils.

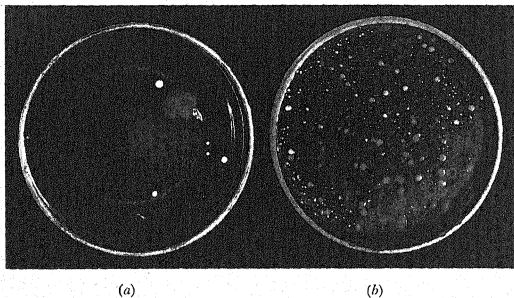


FIG. 27 Bacterial cultures from (a) a clean and (b) a dirty drying cloth

There is danger, also, from the stacking of plates still wet with dirty wash water. The surface of dry crockery will not encourage the survival of bacteria, whereas the microbes left in pools of wash water on a plate may not only survive but multiply. It is desirable, therefore, to leave crockery clean, dry, and ready for the next meal; and plates should be taken from very hot water and allowed to drain dry vertically in a rack.

Experiments have shown that utensils artificially contaminated with bacteria can be sterilized by exposure to hot water at  $170^{\circ}\text{F.}$  for about thirty seconds. China and utensils rinsed with water maintained at a temperature of  $170^{\circ}$  to  $180^{\circ}\text{F.}$  will dry rapidly in the air. When it is considered necessary to use cloths either for drying or polishing they should be washed and boiled frequently. In some establishments a bowl of water containing cloths used in the kitchen is boiled continuously throughout the day, either on a cooker or a gas ring.

When a final hot rinse is used, crockery whether whole, chipped or cracked can be rendered safe. Chipped or cracked crockery is unattractive, yet sometimes its use is unavoidable, and provided it receives a sterilizing rinse after washing it is as safe as the undamaged article. Certain plastic materials can be washed in the same way without ill effect.

Another type of two-sink system, recently designed by a large catering firm, is of stainless steel throughout; hot water, from a gas boiler, flows continuously to the rinse sink, circulates into the washing sink containing a cleansing agent, and flows continuously away. It is, therefore, mechanically impossible to allow food waste to accumulate in the wash and rinse waters. The operatives in a large store where these units are on trial are very satisfied with the system.

### Chemical sterilization

Sterility of eating and cooking utensils can be achieved also by chemical means, and although hot water is recommended as the safest method there are circumstances where chemical sterilization in rinse water containing chlorine or in wash water containing a bactericidal detergent may be the only possible method. There are objections to the use of many sterilizing agents, and the amount used needs to be carefully controlled because there is no ready means of seeing when the disinfecting power of the solution is exhausted. The effect of hypochlorite, for instance, is easily destroyed by food debris and by hot water, so that articles must be washed in cool water, which necessitates cloth drying; furthermore, hypochlorites are destructive to silverware and clothing and they are hard on the hands.

The relative virtues of dish-cloths and mops is a matter for discussion, with a mop the hand need not be exposed unnecessarily to cleaning agents. All cloths, mops, and other aids to washing should be boiled daily.

The installation of sterilizing sinks as described above may be impracticable in some establishments. It is noteworthy that in certain countries, for example Scandinavia, where hygiene is far advanced, public health laws have been instituted which insist on the heat sterilization of all eating and cooking utensils. Where this cannot be attained by specially designed apparatus, common receptacles such as bowls and saucepans, are adapted for the purpose. The articles may be placed on a perforated disk over a small quantity of water which is kept boiling in a covered container on a gas ring or some other convenient source of heat.

### Machine dish-washing

Dish-washing machines are extremely useful and labour-saving. The usual designs include detergent and rinse sprays, the temperatures of which can be controlled and maintained at 49° to 60° C. (120° to 140° F.) and 66° to 82° C. (150° to 180° F.) respectively. The plates are stacked in carrier racks, so that their maximum surface is exposed to the jets of water which play over them from above and below as the

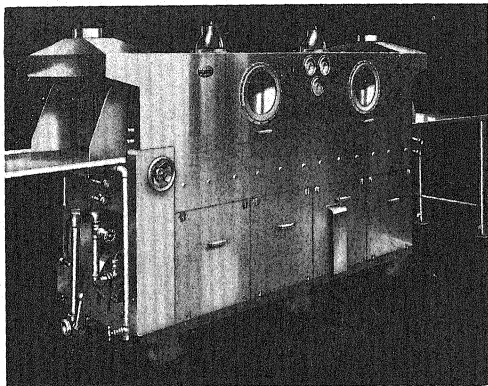


FIG. 28 Large spray type dish-washing machine

racks pass through the machine on a movable belt. The whole process is short and takes no longer than from forty to forty-five seconds.

The wash water, containing a suitable detergent, is held in a tank and is continually re-used, the overflow running away to waste. The detergent strength must be reinforced from time to time. The rinse water comes straight from the mains and is usually recirculated into the wash tank. On the more elaborate machines there may be a final row of sprays delivering cold water from the water supply; this water is not recirculated but runs to waste. In general the articles are delivered hot and steaming from the machine and they are rapidly air-dried.

The efficiency of these machines depends largely on the maintenance of the wash and rinse waters at the correct temperatures and also

on the use of a good detergent at the correct strength. A carelessly run machine can give bacteriological results no better than those from the worst type of hand-washing.

It was observed on one occasion that operatives taking plates from the exit end of a machine were wiping them with cloths; they explained that particles of food were still adhering to some of the plates as they emerged from the machine. In this case there were several things at fault. The detergent was unsuitable because it frothed excessively

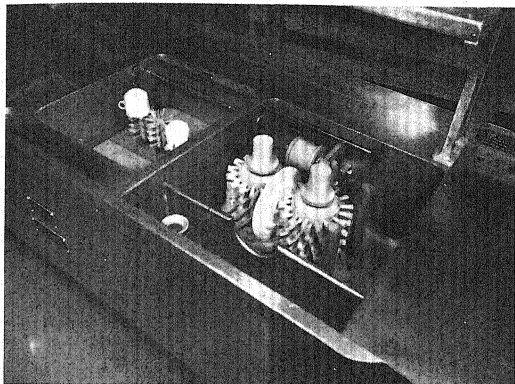


Fig. 29 Immersion and brush type of dish-washing machine

and was obviously unable to move the particles of food from the plates, which were also stacked badly in the racks. The temperature of the rinse water was far below that recommended, and the results obtained from plate swabs gave the highest bacterial counts ever noted for machine-washed articles. The machine was newly installed and the operatives had not learnt to use it correctly. In another large washing machine the metal runway which should have drained the water from the exit end of the machine to the sink did not slope sufficiently to allow the water to run away. Pools collected, and on bacteriological examination it was found that this water contained many millions of bacteria. The plates were stacked in piles of six to twelve on the runway so that the bottom plate of each pile became

heavily contaminated with bacteria, which were passed on to a second plate when one pile was added to another.

There is a smaller type of spray machine that can be worked by one operative, in which wash and rinse sprays are contained in one unit. The articles are racked and the racks are lifted by hand into the machine. A manually operated lever controls the flow of the wash and rinse waters from the upper and lower sprays. The timing is not

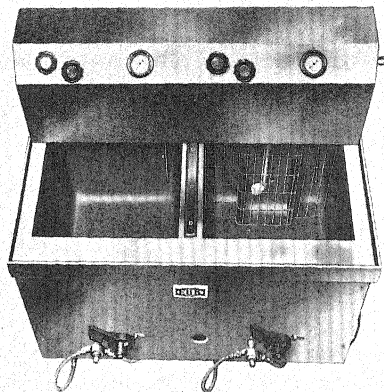


FIG. 30 Small two-sink immersion and turbulence dish washer

automatically controlled, therefore the operative must judge roughly how long to expose articles to wash and rinse waters.

The less complicated types of dish-washing machines include two- and three-tank systems employing brush or turbulent mechanism for the forceful removal of food particles. The brushes in use on the latest machines have nylon bristles, which are cleaned more easily than the pig bristle used in former days; these machines have heating elements to provide the correct temperatures for wash and rinse waters. Some small units consisting of either two or three sinks may be seen in school canteens, as well as in restaurant kitchens. Wash and rinse waters are maintained at nearly boiling point and the wash tank is supplied with a propeller which continually churns the water. The

dishes are placed in the wash and rinse section for a convenient length of time. The method is probably too slow for those establishments using a large number of plates at any one time but the bacteriological results from articles washed in this way have been excellent.

It is debatable whether any useful purpose is served by the routine swabbing of crockery and cutlery in order to observe a bacteriological standard of cleanliness. In a recent survey of twenty restaurants and canteens the main divisions for classification were based on washing-up methods, and efficiency was judged by bacterial counts. The classification was carried out as follows:

1. Premises with one sink only.
2. Premises with twin sinks—wash-rinse arrangements.
3. Premises having two sinks—the second being a sterilizing sink maintained at a constant temperature.
4. Premises using a mechanical dish-washing machine.

In the first group, in which one sink only was used, twenty-eight groups of articles were examined, such as plates, spoons, forks, and cups; fourteen of these showed contamination with bacteria from the nose or throat, while nine showed intestinal bacteria.

In group two the general bacteriological standard showed a slight improvement over that in the first group, but high counts, sometimes in the region of some thousands per utensil, were obtained. Thirty-one groups of articles were examined, and four showed contamination with organisms from the nose and throat, while six were contaminated with intestinal organisms.

In the third group, giving the best results, long-handled metal racks were used for immersion of crockery and utensils for not less than thirty seconds in a sterilizing rinse sink maintained at a temperature of  $170^{\circ}$  to  $180^{\circ}$  F. Thirty-eight groups of articles were examined; three only showed contamination with nose and throat organisms and three showed contamination with organisms from the intestine. Plates were not wiped, but stored in the hot-plate containers; cutlery, however, was wiped to prevent rusting. At least 53 per cent of articles in this group attained the United States Public Health standard of 100 or less bacteria per utensil and absence of any respiratory and intestinal organisms.

The results for group four, using machine methods of dish-washing, varied widely according to the efficiency of running the machine and also according to the type of machine. The temperatures of the rinse waters from most of the machines was far below those recommended, and in many instances the utensils were



hand-dried as they were taken out. In this fourth group the best results were obtained from a twin-sink machine, already described, fitted with a thermostatically controlled heating mechanism in both wash and rinse sinks. Gas, steam or electricity can be used and the correct temperature conditions maintained without difficulty. Water in the first sink, containing a cleaning agent, was agitated violently by means of a paddle. After immersion in this tank for a convenient time the racks containing the crockery and cutlery were transferred to the heated rinse tank maintained at a temperature of about 180° F. In some models of this machine a third tank is included in which the crockery and utensils are freed from cleaning agents before they are transferred to a sterilizing rinse. All tank waters were changed at intervals of two hours. Swabs taken from crockery and utensils were bacteriologically sterile.

The unsatisfactory results obtained from some machines were obviously due to lack of care in the supervision and running of the machines. Thirty-five groups of articles were examined in this group; of these, fifteen showed contamination with organisms of respiratory origin and eleven with organisms of intestinal origin.

A certain number of kitchens were visited daily for a week or more; the counts obtained from the samples taken each day varied considerably. Sometimes the variation could be correlated with a change in technique. For instance, damp cloths were used on some occasions to wipe the plates emerging from the machine, and counts from these plates were very high. On other days plates were allowed to drain dry without further wiping, when much lower counts were obtained.

A few kitchens used a rinse solution containing a high concentration of hypochlorite; the results were regularly good for dishes rinsed in this way. A hypochlorite rinse, if carefully controlled, can produce almost sterile articles. It is considered, however, that the routine use of hot-water sterilization is more efficient and practicable for a kitchen staff who may not take time or trouble to control the use of hypochlorite.

It is hoped that some simpler method may be used in the near future to estimate the efficiency of dish-washing.\*

### Detergents

A detergent is a cleaning agent made of soap or a soap substitute; it may be a mixture of alkaline materials and a substance which will soften the water, or it may be an organic surface active agent. Its

\*Recent work has shown that a powder dusting test is useful for the control of dish-washing and the comparison of detergents.

function in dish-washing is to help in the removal of all traces of food particles from the utensils. This insures that all surfaces will be readily accessible to sterilization either by heat or by some chemical agent and that the survival and multiplication of micro-organisms in food residues will not take place in or on the utensils.

The selection of a detergent for a particular purpose will depend on certain factors, such as the nature of the substance to be removed, the material of the article or the surface to be cleaned, whether the hands must come in contact with the solution or whether it will be used in a machine, and the chemical nature of the water, i.e. its degree of hardness. It may be an advantage to use a cleaning agent possessing some bactericidal power. It is quite impossible to lay down clear recommendations on the particular type of detergent to be used in different circumstances.

The majority of detergents are cleansing agents possessing little or no sterilizing properties, but some of the organic substances manufactured recently, such as the quaternary ammonium compounds, are able to kill certain bacteria. Other detergents may combine good cleansing substances with a hypochlorite, so that the two functions of cleaning and sterilizing may be accomplished by the one liquid or powder. Mixtures of this sort may be of use in small establishments with very limited washing-up arrangements, such as country cottages, the small kitchen attached to a hospital ward, and the fair or sports ground and also when the bacterial cleanliness of ice-cream servers, cups, and other utensils in use by mobile vans is required. They may be used also by the food vendors for washing their hands.

The general properties of a good detergent should include:

1. Wetting—the ability to wet readily the utensils being cleansed.
2. Emulsification—the ability to break up and disperse fat.
3. Dissolving—the ability to dissolve food materials, principally protein.
4. The ability to break up any solid food matter, no matter what it is.
5. The prevention of scum and scale formation in hard water.
6. Rinsing—the property of being easily rinsed away.
7. Harmlessness to man.

No one substance possesses all the required properties, and most proprietary detergents consist of a mixture of substances, the exact formulae of which are seldom divulged.

Soap is a simple detergent, but its use for washing-up is limited in hard water. It is common knowledge that in hard water the washing

of greasy dishes with soap results in scum formation. This scum is a mixture of dirt and hard magnesium and calcium salts from the water which have been precipitated out of solution by the soap. A water softener is an agent which keeps these salts of hard water in solution so that the cleaning agent itself may be more effective.

Most good detergents incorporate a water-softening agent. Some substances used for this purpose are common washing soda (sodium carbonate), trisodium phosphate and sodium metasilicate and also the hexametaphosphate, tetrphosphate and pyrophosphate salts of sodium.

Sodium hydroxide is a good dissolving agent but its caustic action is injurious to the skin. A good inorganic detergent powder might contain a mixture of sodium hydroxide or sodium carbonate, trisodium phosphate, sodium metasilicate, and sodium hexametaphosphate, thus combining cleansing and water-softening properties. The proportion of each ingredient would depend on the purpose for which the powder was intended and the hardness of the local water. These strongly alkaline powders are useful for many purposes, for crockery, cutlery, and milk, ice-cream or other food containers. It must be remembered, however, that they are hard on the hands and they are, therefore, best used in machine-washing where a cleaning agent which does not froth is of particular value.

The organic detergents include those which are manufactured as a by-product of the oil industry. They are positively charged (anionic) and can be used in combination with soap, which is also anionic. They possess most of the properties which make a good detergent; they wet readily, emulsify fats, break up dirt particles, and soften the water by forming soluble calcium and magnesium salts. They are not usually alkaline and are preferable to the caustic inorganic powders for hand-washing. On the other hand they often froth too much to be of value in dish-washing machines. The anionic detergents are sometimes mixed with a hypochlorite to combine cleaning and sterilizing properties. The quaternary ammonium compounds are cationic detergents, that is, they are negatively charged and cannot be mixed with soap. Some foam readily while others do not. They exert a bactericidal action on some germs and may be mixed with inorganic materials to form satisfactory cleaning and sterilizing agents.

There is one more group of organic detergents or surface active agents as they are called, those which are nonionic, that is, they are neither negatively nor positively charged. They have good cold-water wetting properties and are useful detergents with good stability towards hard water, acids and alkalis.

### The washing of glassware in licensed premises

The conditions which prevail for washing glasses in licensed premises are different from those for dish-washing in other catering establishments. All cleaning is done at the bar counter, and at rush hours there is a considerable turnover of glasses in a short time. It is necessary, therefore, that some system should be designed for quick washing and sterilizing of these glasses.

The Catering Trade Working Party of the Ministry of Food recommended the separation of glass-washing from bar service. An island should be provided behind the bar where all glasses and other drinking utensils are washed either by the bar attendant or by staff specially engaged for washing-up duties. For new installations the two-sink procedure laid down in the Standard and Target Codes of the Working Party should be used, and it is recommended that an adequate supply of glasses should be available, to allow time for the washed glasses to cool before they are required for further use. Cloth drying after a hot sterilizing rinse would be unnecessary, but to impart a final polish to the glasses a clean dry cloth could be used on the dry glass.

In places where it would be difficult to install two tanks it is suggested that a combined sterilizing agent and detergent should be used in the single tank, but there must be properly controlled use of the sterilizing substance combined with sufficient changes of water in the tank, and the adequate supply and use of clean dry cloths.

During the last few years two workers have found that the use of a bactericidal detergent, such as a quaternary ammonium compound, in the water used for washing beer glasses considerably reduced the bacterial count. Their recommended procedure, which includes the use of an automatic dispenser for delivering a constant dose of the cleansing and sterilizing agent into the sink of known capacity, has been adopted by the Brewery Trade.

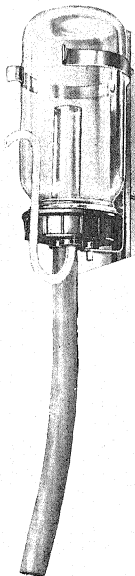


FIG. 31 Automatic dispenser for delivering detergent solution

Special washing machines for glasses are available and a small type of machine can be fixed to the bar itself. Used glasses are subjected to a detergent wash and a hot rinse spray; if it is desired to cool the glasses rapidly a cold spray can be used finally (Fig. 32). Although it is recommended that machine-washed glasses should be air dried or used wet there are conventional objections to these procedures; clean, dry cloths should be available in ample supply.

A note of warning has recently appeared on the use of the newer detergent materials for washing crockery, cutlery and glassware. It has been suggested that some of these materials may be harmful if

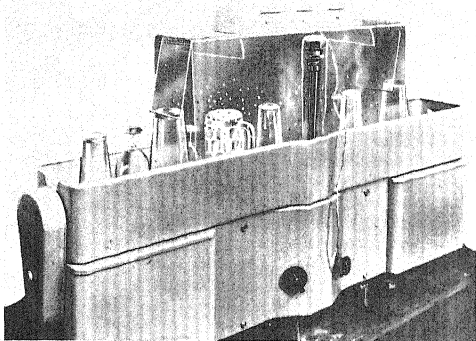


FIG. 32 Glass-washing machine

ingested in small amounts over long periods. Only long-term experiments can find the answer to this problem. In the meantime detergents used for the cleaning of food utensils and equipment must be removed afterwards by thorough rinsing, in order to eliminate all traces of possible toxic substances.

### **The large food container**

Amongst the more important articles to be kept clean and sterilized are the large food containers used to transport meals from central school kitchens to the children in surrounding schools. There should be provision for the sterilization of these containers and for their

subsequent drainage. Food residues, if allowed to remain, may retain bacteria able to contaminate the new food.

When freed from all residual food particles, each container should be thoroughly washed in a warm detergent solution, rinsed free from the wash water, steam sterilized and drained; the inside should not be touched again before it receives the next batch of food. It has been shown that high bacterial counts are common for containers washed in the ordinary way and cloth dried. When it is considered that cooked food may remain in these containers for a considerable time, it is obviously necessary to ensure that the residual bacteria on the inner walls of the container are destroyed by steam sterilization and not reintroduced by contaminated cloths. The lids of the containers should also be sterilized.

The Target Code of the Catering Trade Working Party in Item E (12) emphasizes the need for an adequate exposure time to steam and it is suggested that a clock with a large minute hand should be provided beside the steam jet. Adequate sterilization in steam chests or in tanks containing boiling water may be substituted in special circumstances.

As an alternative measure, where there are no facilities for steam sterilization a final rinse in hypochlorite solution should be given.

It is not intended here to give detailed information on the cleansing of plant equipment used in food manufacture; it is necessary only to stress its importance. This is particularly true for ice-cream equipment, the cleanliness and sterility of which is necessary for the purity of the ice-cream mix and for the maintenance of Grade I samples. It is probable that the same applies to many other foodstuffs manufactured with the help of machines.

The basic principles of any cleansing technique include a hot detergent wash, followed by some method of sterilization by water, which should be nearly boiling, steam or chemical agency. The use of hand cloths to dry equipment should be necessary only if hot water is unobtainable and reliance has to be placed on chemical disinfection. Those which must be used should be washed and boiled frequently. Articles should be air dried as rapidly as possible and they must be stored *dry*.

### **Infant feeding bottles**

Although far removed from the problem of keeping the adult population free from food-borne infection, the proper care of feeding bottles and teats is an important factor in preventing the spread of enteritis amongst infants via their feeds.

The following abstract is taken from the Medical Research Council Memorandum No. 11 (Revised Edition, 1951). "When feeds are finished, the bottles should be thoroughly rinsed in cold running water, cleansed with a detergent to remove milk film and rinsed again in running water. Brushes used for cleansing bottles should be disinfected after each period of use. Teats and valves should be turned inside out after each use, gently scrubbed to remove all traces of feed and boiled for not less than two minutes before being used again. Between each feed, bottles should be disinfected by boiling for not less than two minutes in a special bottle sterilizer. It is important that the bottles should be totally immersed in the water. An investigation into the use of hypochlorite solutions as a possible alternative method for disinfecting bottles is being undertaken.\* In many American hospitals, sterilization of bottle-feeds after they have been assembled is practised. The entire unit of bottle, infant feed, teat, and protective teat-cover is subjected to sterilization by heat."

\* The results compared with those from the boiling method showed that sterility could generally be obtained by the use of either hypochlorite or heat provided the correct technique was used.

CHAPTER XII  
KITCHEN DESIGN AND EQUIPMENT  
(L. Kluth)

In the construction of catering establishments there is naturally a wide range of structural methods and materials employed. The basic requirements for any building to be used for the preparation and service of food are that it must comply with the ordinary standards of stability, durability and protection against the weather which are applicable to all buildings.

It is not appropriate here to attempt to deal with the many details of construction involved in the erection of buildings; these may be studied at length from text-books dealing exclusively with the subject. It is sufficient to say that the traditional forms of brickwork or masonry with slated or tiled, or reinforced concrete and asphalted roof covering probably cannot be improved upon for permanence; whilst the newer light constructions of steel framework covered with corrugated asbestos cement sheets or filled in with lightweight concrete or hollow blocks, must be acceptable for buildings of shorter duration.

### **The interior**

When it is assured that the building fulfils its primary function as a shelter, the internal arrangements which would be specially suitable for food premises should be considered.

### **Lay-out**

It is generally agreed by those interested in food hygiene that there is less likelihood of food infections being spread when handlers work in congenial surroundings. Certainly it may be supposed that intelligent people made conscious of their responsibilities to the public, when employed in premises where work can be done in an orderly and unhurried manner, can and will pay more attention to the demands of hygiene. Fatigue and strain and attendant carelessness are also reduced by good ventilation and lighting, while readily accessible and easily cleaned surfaces make the attainment of sanitary conditions less arduous.

As far as can be ascertained, no authority has ventured to suggest what minimum working space should be provided in food-preparation



rooms. But, if school kitchens designed and erected by the Ministry of Works and Ministry of Education may be taken as setting a reasonable standard, it will be observed that from 4 to 6 feet of working and passage distance is allowed between islanded cookers and wall sinks or benches.

So far as overall air space is concerned, the legal minimum is laid down by the Factories Act, 1937, at 400 cubic feet per employee. This appears to be based on the old-established standard of 1,000 cubic feet of fresh air being needed per person per hour supplied on a reckoning of two and a half air changes per hour, a figure often quoted as obtainable by natural ventilation. Since it is usually necessary to supplement the natural ventilation of kitchens by mechanical means, and since the equipment occupies a large area of floor space in proportion to the number of employees, this standard can invariably be met in rooms of the normal height of 8 to 10 feet.

The present trend in kitchens is to install preparation equipment at the sides (where waste can be conveniently drained away), and to erect island cooking apparatus in the centre of the room where there can be localized ventilation. This appears to work very well. Where necessary, it is desirable to provide a separate room for the washing-up of crockery and other utensils.

As a rough guide to floor area, etc., Table XII, based on post-war school-meals service premises, may be of use, but it must be remembered that midday meals only are prepared.

### Floors

Traffic in food rooms may vary from normal foot passage to heavy iron-wheeled trolleys, and the durability of the floor surface must meet the demand of the particular premises. Apart from this, the major requirements are that the floor must be impervious to moisture and not adversely affected by grease, salt, vegetable or fruit acids, or other food scraps. The finish of the floor should also be such that joints and crevices should not provide lodging for dirt or for insect pests.

In the construction of the floor, angular corners should be avoided, and in particular, internal angles and the junction of the floor with the skirting should be coved.

Asphalt floors are dust-free and waterproof, and do not provide a harbour for vermin; they are, however, liable to erosion by acids and grease, and they will not bear concentrated weights. Pitch mastic floors, on the other hand, are resistant to damage from the action of fatty acids. Quarry tiles when laid well are excellent in all respects, except that they are slippery when wet; and they can be used for whole

TABLE XII *Approximate Floor Areas of School Kitchens (Areas in square feet)*

No. of meals	Kitchen	Vegetable store	Dry store	Larder	China store	Boiler house	Staff rooms	Refrigerator capacity (cubic feet)
750 in two sittings	1,900 including two serveries and wash-ups	100	80	96	—	—	184	50
600 in two sittings	1,420 including servery and wash-up	100	80	72	—	—	150	25
500 in two sittings	1,200 including servery and wash-up	100	72	80	—	100	160	25
350	750	90	90	67	48	72	67	18
250	600	70	70	36	30	50	36	18
150	420	35	70	70	24	36	35	18
100	300	36	42	42	36	36	30	—
75	210	16	28	28	—	—	—	—
40	170	15	24	24	—	—	—	—

floor covering or as bases for free-standing equipment in rooms where the rest of the floor is pitch mastic. This arrangement is probably the most satisfactory.

Softwood board and joist floors are to be deprecated since the sub-floor space can provide a harbour for rats and mice, the surface is absorbent and the joints between the boards form dirt pockets and provide refuge for insects. Linoleum, particularly if laid in single or jointless pieces with a mastic adhesive, is an improvement; but it cannot be expected to withstand heavy wear or much concentrated weight, as in the case of heavy equipment standing on feet of small sectional area.

Hardwood blocks or boards are warm and easy on the feet. While less absorbent than soft wood, they are far from impervious even when well oiled, and they are not entirely suitable in places where much waste water is likely to reach the floor.

Plain concrete floors may be dusty and irregular and, when not laid in properly proportioned sections, are liable to crack and break. The inclusion of granite chips (granolithic) and possibly a proprietary binder, or marble chips (terrazzo) in the cement mix instead of gravel, produces a very fine non-absorbent, pest-proof, and dust-free surface. Terrazzo, however, is slippery when wet and cracks appear almost invariably sooner or later.

Composition floors are manufactured from a basic cement of magnesium oxychloride and a filler which may be sawdust, powdered cork, sand or clay, together with a pigment. Many such floors have proprietary names and are laid by specialist contractors. Neither too much water nor any soap or soda should be used in cleaning such floors. Polish and linseed oil preserve the surface.

Rubber laid as tiles or as strips on adhesive is not, in general, to be recommended for other than domestic kitchens. Although easily cleaned, rot-proof, unattractive to vermin, and relatively hard-wearing, it may become dangerously slippery when wet or greasy and may soften and corrode under the influence of fatty acids.

Cork tiles or strips form a pleasant floor finish, easily cleaned, and relatively durable. Like rubber, however, they have to be specially laid, and probably cost more than is justifiable for commercial kitchens.

Steel tiles set in cement mortar are extremely useful in situations where heavy traffic is likely.

### **Walls**

Unfortunately there does not seem to be a wall finish which will satisfy the two major requirements of food rooms in which steam is

produced. Walls must be smooth and impervious, to allow easy cleaning, but it is also desirable that the surface should be warm and open textured to minimize condensation. Until a material which combines these qualities is available, it must be accepted that if the first requirement is fulfilled the problem of condensation must be met, as it can be to a large extent, by adequate ventilation.

Plain brick walls cannot be regarded as satisfactory, since bricks are absorbent and do not provide a really smooth surface even when the mortar joints are finished flush with the face of the wall.

Plastered walls, especially if finished with a final coat of hard plaster covered with a high-gloss paint, will overcome the irregularity of the structural material of the wall and provide a jointless and reasonably non-porous finish.

Soft plaster and lath and stud partitions are rarely used now; this type of construction is liable to harbour rats and mice, which may break into the cavity by gnawing through the skirting-board. Rendered cement and sand mortar produces the same result as plaster and is more durable and vermin-proof. Proprietary anti-condensation plasters are obtainable; their open-textured surfaces rapidly assume air temperature and accordingly prevent condensation if a reasonable air humidity is maintained.

Match-boards are most unsuitable for wall surfaces. They may shrink or swell, and their joints collect dirt; they are easily penetrated by rodents, and when hollow-backed, as they often are, provide an excellent harbour for these pests. Fibre board sheets have considerable insulating value and generally they are not conducive to condensation unless hard faced, but they are not pest-proof and will not withstand frequent washing. The basic materials are woodpulp or root or cane fibre, sawmill waste, straw, waste paper, bark and similar vegetable fibres. Although sheets of these materials may be used in relatively large sizes, joints are unavoidable in covering wall surfaces. The use of cover slips or battens over such joints seems to be undesirable since they form a minor dirt pocket. It is better for the joints to be covered with a strip of hessian "scrim", and the whole surface floated with plaster or covered with plastic paint.

Materials with a vitreous surface include glazed tiles, glass tiles, glass bricks, and various proprietary opaque glass or mirror panels. Of these, glazed tiles are preferable; although made in a relatively small unit size, the joints are fine, smooth and flush, whereas other types must be screwed into place and it may be necessary to use cover slips at the joints.

Other hard-surface panels are made of asbestos cement sheets or

plastic sheets. With all hard panels a wall surface of excellent hygienic quality is obtainable, but raised joint coverings and projecting fixing methods should be avoided.

### **Ceilings**

As a general rule it is desirable for roofs or floors over food-preparation rooms to be underdrawn or ceiled, and it is probable that the traditional and most common material, plaster, is quite as suitable as any other in most situations, although other materials have advantages in certain circumstances. Ceilings, as distinct from the undersides of roofs or upper floors, serve four purposes: to provide a smooth non-dust-collecting internal surface to the room, to prevent dust filtering down into the room through the upper floor or roof, to improve the degree of insulation of the roof, and to provide a level under-surface with no pockets in which hot humid air can collect and stagnate.

Fibre boards have a better insulating value than plaster; they are self-supporting and more easily fixed in some conditions, e.g. by patent clips to the underside of light steel-framed corrugated sheet roofs. Patent anti-condensation plasters which incorporate porous but non-permeable materials reduce the rate of thermal transmission and have relatively warm surfaces.

### **Decorative finishes for walls and ceilings**

The hot and humid atmosphere in kitchens frequently plays havoc with wall and ceiling paints and distempers, and causes surfaces to blister, peel and flake. Wherever walls which are not of impervious material may be splashed with greasy water a non-absorbent washable coat of paint or good oilbound distemper is essential, and above this line some easily renewable and light medium, such as whitening or colour-wash, should be maintained. Six feet above floor-level is suggested as a suitable height for a washable dado.

Granulated cork has long been painted on the walls and ceilings of crews' quarters in ships to minimize condensation, and proprietary paints incorporating powdered cork are being used successfully in kitchens for the same purpose.

### **Lighting**

In general no obligatory standard of lighting exists for kitchens in this country, and from observations of many establishments it may be questioned whether an enforceable standard is not necessary. The code of the United States prescribes a minimum illumination equal to 10 foot-candles on working surfaces and the Regulations of the

Minister of Education relating to kitchens attached to schools impose a similar requirement and a daylight factor of 2. This amount of light should not be difficult to attain by natural light on medium days, and from modern artificial sources.

Although there are other illuminants which have their uses in very remote places or temporary situations, electric current is now generally available.

Both tungsten filament lamps and strip (fluorescent) lighting are in common use. Although more expensive to install, the strip lighting is more economical in current consumption. Cheaper to replace, a tungsten lamp gives best light when used with a reflector fitting such as British Standard Specification (B.S.S.) 232-1926 or Ministry of Works A36.

Lighting points should be as nearly as possible directly above sinks and food-preparation benches. Preferably they should be set back 18 inches from the front of the sink towards the wall so that the person who is washing up casts no shadow on the contents of the sink.

Working surfaces are not the only points which need adequate lighting; no part of the premises should be so dark that it is difficult to see whether utensils are clean or not. If the food room is reasonably spacious for the work performed, convenient in shape and lay-out, and decorated in light colours, then a system of lighting which satisfies the standard of working surfaces can reasonably be expected to meet the needs of other parts of the room by diffusion. When direct sunlight enters any workroom it is likely to be tiresome to the eyes of the workers, and in food-preparation rooms it is also a source of undesirable warmth to perishable foods. For these reasons, north lighting is to be preferred, otherwise, precautions should be taken to obtain indirect lighting.

### Ventilation

For ordinary purposes, natural ventilation of buildings is sufficient except in rooms which are over-populated. The by-products of cooking, however, can rarely be efficiently removed from a kitchen except by means of mechanical extraction equipment.

The British Standards Institution recommends (1950) that provision should be made for up to twenty air changes to take place per hour in large kitchens, and it is obvious that natural ventilation could not secure this rate of air change. One may venture to suggest that such frequent overall change of the air in a kitchen is neither necessary nor desirable, nor the most satisfactory method of controlling humidity and cooking odours. Far greater efficiency is obtained by

strictly localized systems of extraction analogous to the methods employed to remove dust from grinding and polishing machines.

The present-day trend towards the grouping of cooking appliances in islands is a convenient method of concentrating these appliances under a collecting hood or canopy, so that ducts and extraction fans

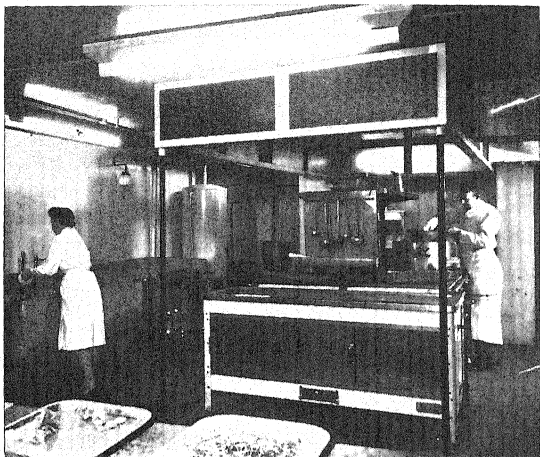


FIG. 33 Wired glass hood over kitchen equipment

may remove cooking odours and steam before they are diffused throughout the room. Installations of this type can be usefully employed also over a wash-up sink, which can contribute a high humidity to the atmosphere of kitchens.

Canopies, although commonly made of sheet metal, are sometimes constructed of wired glass panels in a metal frame, which has the advantage of allowing a reasonable amount of light to fall on the tops of cookers even though the hood may hang low over them (Fig. 33). As a supplement to open windows or permanently open grills, small electric extract fans are of limited value in working kitchens, but they may perform a useful function in regulating the air change in dining-rooms.

Café bars usually have a tea boiler on the counter, the flue of which discharges into the air of the room. There is often a hood or dome suspended above this, but without a duct or trunking leading to the open air. As a means of preventing general condensation in the room, it is, of course, useless; but it must be admitted that it breaks up and diffuses the concentration of heat and water vapour, which would otherwise impinge upon a small area of ceiling immediately above the flue, thus causing rapid deterioration of the decorative finish.

### **Sanitary conveniences and washing facilities**

In common with other premises where persons are employed, buildings where food is handled must be provided with sufficient water closets, urinals, and wash-hand basins for the use of the staff, and in all but the smallest restaurants it may be a requirement (see Public Health Act, 1936, s. 89) for similar provision to be made for members of the public using the building. As to the number of sanitary conveniences considered necessary, there is no legal standard directly applicable, but the Sanitary Accommodation Regulations, 1938, appertaining to factories, may give some guidance, at least for requirements. These regulations lay down a scale of one water closet for every twenty-five females employed and one water closet for every twenty-five males, up to the first 100 employed.

Premises which are licensed by County Councils as places of entertainment are required to provide sanitary conveniences for the public. In Middlesex, for example, for every 1,000 of the total number of persons to be accommodated, two W.C.'s and five urinals for men, and four W.C.'s for women must be provided. If a similar standard were to be applied to catering establishments seating, say, 200 persons or more, it could surely not be considered unduly harsh.

As an example of a suitable scale of washing accommodation, the Welfare Orders of 1927 applied to Bakehouses and Biscuit Factories may be quoted; they prescribe one wash-hand basin of a depth not less than 7 inches and a length not less than 20 inches for every ten employees. It should be noted that these orders are concerned primarily with safeguarding the health of the employees (against dermatitis in this case) rather than the transmission of disease to the public; hence the specified dimensions of the basins, which are intended to permit cleansing not only of the hands but also of the forearms.

The siting of sanitary conveniences in relation to workrooms, habitable rooms and rooms in which food is prepared has long been the subject of statutory control, which, in general, prohibits the



placing of conveniences in such a room or, indeed, in direct communication therewith. Any water closet or urinal used in connection with a food room must, therefore, be entered either from the open air or through some intervening and separately ventilated lobby. The latter arrangement is the common and recommended one nowadays and the lobby is frequently and sensibly utilized as a lavatory by fitting in it one or more wash-hand basins. Because it is particularly important

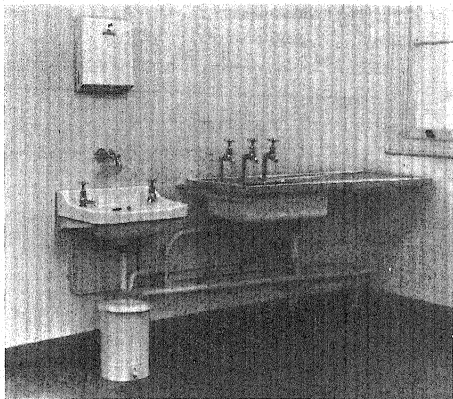


FIG. 34 Hand-washing facilities in a kitchen

for a food-handler to wash after visiting the toilet, it is imperative that washing facilities should be near the conveniences. A worker's hands may also become dirty, and indeed contaminated, from other sources during the course of his employment, so that additional washing facilities should be placed conveniently in the food room (Fig. 34).

Where food-handlers are engaged on more than one floor of a multi-storied building, conveniences and their accompanying wash-hand basins are desirable on each story, but should at least be situated so that each serves not more than two floors. Water closet apartments must be adequately lighted and ventilated either by natural or artificial means.

For wash-hand basins there must be supplies of both hot and cold water (Food and Drugs Act, 1938, section 13). In premises where

a central boiler-fed hot-water system is in operation no difficulty arises in distributing hot water to the wash-hand basins, but when a piped supply of hot water is not available there are several excellent alternatives, such as thermal storage units and instantaneous water heaters depending upon electricity or gas as a source of heat.

Washing facilities do not, of course, finish at the provision of water and basins; soap, in tablet form, or perhaps better still a powder or liquid from a fitted dispenser, is necessary, also nail brushes and some means to dry the hands. The most hygienic methods are provided by paper towels, which can be destroyed after use, the patent continuous roller towel when each portion is used once only, and the many types of hot air hand driers.

### Drainage

The design and general construction of drainage systems are regulated in respect of all kinds of buildings. Of special, though not exclusive, application to food-preparation rooms is the prohibition of discharging obstructive matter into drains (Public Health Act, 1936, section 27) and the imposed necessity for securing the permission of the local authority before installation of a drain inlet in a food store or preparation room (Food and Drugs Act, 1938, section 13).

*Grease interception.* Certain waste products of food preparation are likely to lead to choked drains, such as the fat and grease from washing-up water which are discharged hot and molten, rapidly cool during their passage through the drain and solidify there unless intercepted. Grease traps, the importance of which may lessen with the increasing use of fat-solvent detergents for dish-washing, take the form of tanks holding a body of cold water, sufficient in quantity to cool any inflow of dishwater to below the melting point of its grease content. Inlets and outlets are submerged so that the solidified fat forms a floating curd which must be skimmed off as occasion arises. The greasy waste has an industrial value in soap manufacture.

*Floor drainage.* While it is desirable for provision to be made for carrying away waste water (spillage, cleansing water) from the floor of a food-preparation room it is generally held to be better not to place direct drain openings in a room of this kind, for although the inlet would, according to bye-laws, have to take the form of a properly water-sealed gully trap, the seal might be lost by evaporation or other means, allowing foul drain air to enter the room. Loss of seal may also permit the entry of rats from the drain and sewer. Actually the chances of these difficulties arising are small, because the rate of evaporation from water seals is very slow in Britain and means for

preventing the loss of seal by other causes are well understood and practised. Nevertheless, the accepted way of draining kitchens is to sink glazed-ware channels into the floor in suitable positions, so that waste water can be carried away to a gully situated outside the building. Where the channels cross the open floor a cover-grid should be provided, preferably of galvanized or zinc-sprayed cast iron, to avoid accidents. The grid must be in short lengths and easily removable to allow regular and frequent cleansing of the channel. For simplicity and economy in plumbing work it may be convenient to discharge waste pipes from sinks and wash-hand basins over such channels.

### **Refuse storage**

Unlike the scrap from many industrial and commercial processes, kitchen waste demands particular care and attention while awaiting final disposal owing to its putrescible nature and because of the special needs of the premises which form its source.

Future developments may include the immediate conveyance of refuse from premises by some method of water carriage, such as the Garchey system, which is already in use in multi-storied estates for which it is best adapted; or by the development of disintegrators, which have appeared on a domestic scale, at least, in the United States of America, by which the macerated refuse discharges directly into the drainage system.

Whatever subsequent development may take place, the present mainstay of refuse storage is the common dustbin; and it is unfortunately too rare for this mundane article to receive the discrimination in choice and the care in maintenance which it deserves. The function of a bin is to protect its contents from flies and rats until after it has been emptied. To fulfil these requirements the bin must be of stout non-pervious material—galvanized iron 22 gauge is recommended—cylindrical in form with a slight taper to a narrower bottom to ease the work of those who empty it and for the same reason to avoid dents. The sides should rely on thickness of metal rather than corrugations for strength. The bin should not exceed 2 cubic feet in capacity and it should be provided with suitable handles for ease of handling. The close-fitting lid must have a deep lip, at least 2 inches, as a precaution against disturbance by wind or marauding cats and dogs; there is a British Standard Specification for the construction of dustbins.

For the bin to have an economic and effective life, it must be used carefully. It should not be filled to overflowing so that the lid balances on a pile of exposed refuse, and after it has been emptied the bin

should be scrubbed or hosed inside and out and left to drain dry. As far as possible any wet refuse should be wrapped in newspaper or other waste paper; this enables the bin to be emptied cleanly without rough handling.

The amount of refuse storage depends partly on the frequency of collection. The usual maximum storage time is seven days, but it may be one day only in some areas. It is not always practicable to site the dustbins for the convenience of both the refuse collector and



FIG. 35 Refuse disposal—bins housed on iron stands

the occupier of the premises. Where the dustbins are some distance from the food room and scraps are kept in the room, a suitable covered vessel should be used and emptied into the bins at least at the close of each day's work.

Yards belonging to food premises should be properly paved and drained, and this is particularly necessary for the ground which provides the site for the refuse bin. A stand for the bins constructed of iron rods or angle iron to allow a clearance under the bins of about 9 inches is an advantage. This extra height is helpful when the bins have to be lifted for emptying, but the main purpose of the arrangement is to allow the yard pavement to be properly hosed down and swept.

### Equipment

Just as the surfaces of the walls and floors must be of a texture which is easily cleaned, so all surfaces with which food comes in

contact must allow for efficient cleaning almost to a state of sterility. This becomes difficult, if not well-nigh impossible, when wood is the material concerned. For various reasons, wooden-topped work benches, wooden draining boards, and teak sinks have long enjoyed popularity in the catering trade. They are all, however, capable of harbouring bacteria in cracks and corners, and experiments have

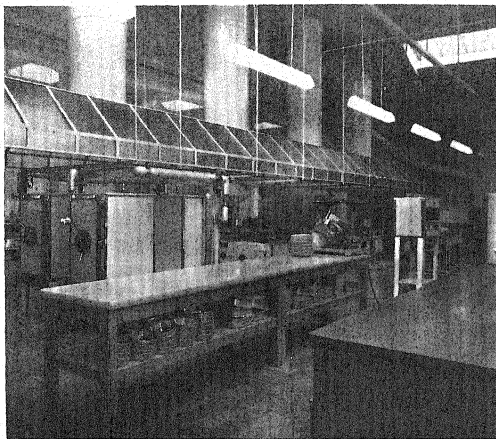


FIG. 36 Good kitchen

already been quoted where intestinal bacteria were recovered from a wooden sink even after it had been washed down with a strong soda solution. Wooden equipment is therefore unsuitable for food work. It can be satisfactorily replaced by hygienic alternatives such as linoleum, plastic, or metal table-tops, pressed metal combined sinks and draining-boards, or glazedware sinks.

Cooking vessels and other utensils may be made of a wide range of materials. There have been no reports of illness following the consumption of any foodstuffs prepared in contact with the more common metals such as aluminium, copper, tin or other various alloys. Zinc poisoning, however, occurred in two incidents where apple rings were prepared in a galvanized iron container; the outbreak

of chemical poisoning from lemonade prepared in a chipped enamel container provided a classical example of antimony poisoning.

### Hot water supply

The hot water requirements of food-preparation rooms vary both in quantity and temperature and may have to be met in different

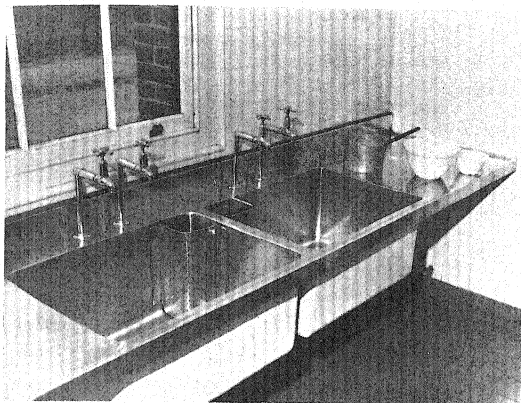


Fig. 37 Stainless steel twin sink and draining-board unit for washing cooking utensils

ways even within the same premises. It may be said that the basic needs are relatively small quantities of boiling water for tea-making, medium amounts of warm water (about 120° F.) for hand washing, and large quantities of hot water for utensil washing (140° to 150° F.) and for a sterilizing rinse (180° F.).

The tea boiler is almost invariably an independent and efficient gas-burning instantaneous heater of which there are several types made by various manufacturers.

Hot water installations do not usually provide a supply of water at sterilizing temperatures unless specifically designed for the purpose, and not all appliances on the market are capable of doing so. For this reason water for hand washing and for dishes is often supplied independently, either from storage at 150° F. after heating by an

independent solid fuel, oil, gas or electrically heated boiler, by indirect heating from a steam or hot water central heating system, or by delivery from an instantaneous gas water heater. When such a supply, piped or otherwise, is provided, it is a relatively simple matter to raise the temperature of the water in the sink used for the "sterilizing" rinse by means of a thermostatically controlled gas burner or electrical unit or by steam. This solves the problem of loss of heat from the sterilizing rinse water while work is in progress. Another system which has been used successfully to overcome this difficulty is the provision of water, heated to 180°F. by an independent boiler, directly to the sterilizing sink from which there may be a constant overflow to the washing sink as the water cools.

For hand-washing supplies, where a piped run is not practicable from the main hot water supply, small gas geysers or electric thermal storage appliances are invaluable, but they must not be expected to supply water at sterilizing temperatures for washing-up.

CHAPTER XIII  
CONTROL OF VERMIN  
(L. Kluth)

The importance of food conservation during and after two world wars has resulted in a Government conviction that the total destruction of various species of small animals and insects is both practicable and necessary.

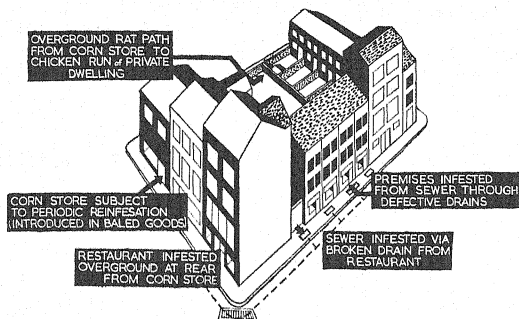


FIG. 38 Block control: an example of related infestation in separate buildings which require simultaneous treatment

### Rats and mice

It is probable that estimates of the material damage caused by rats and mice are often overstated, and the implication of these rodents in the spread of infection in Britain is probably not considerable, although not insignificant, at the present time. Nevertheless, the presence of such vermin in and around the habitation and food stores of man is repugnant, apart from being a source of some loss and a danger to health.

Encouraged by new enactments, local authorities have been able to engage in practical rodent destruction to a greater extent than was possible under the powers granted them by earlier legislation. There must be few town or district councils today which do not maintain a



staff of operators trained in methods of rodent destruction, upon which the occupier of infested premises can call for practical assistance. It should be pointed out that the onus of keeping premises free from vermin rests upon the occupier, and the councils are entitled to make a charge for such services. Where serious damage is being caused to food by any pests the occupier is under an obligation to report the infestation to the authorities.

*Block control.* An infestation is not always confined to a single human tenancy, nor indeed to a single building; the rat or mouse colony may perhaps spread through several adjoining premises. Obviously when such is the case an individual tenant might kill off the vermin in his premises, only to find them replaced in a very short time by an overflow from his neighbour's property. Concerted action over the whole infested territory or block is necessary before all the rats can be destroyed. This is usually most conveniently carried out by the local authority and is known as block control (Fig. 38).

*Vertical block control.* An infestation may extend below ground to drains and sewers, so that vertical block control schemes must include treatment for the destruction of rats in underground pipes as well as in the building above.

### **Rat proofing**

Some comment has already been made (page 116) upon structural materials, their properties of resistance to penetration by rodents and their use as an abode for these animals. Naturally, stone and metallic materials have basic advantages over those of a fibrous nature. Impenetrable materials, however, are of little value if the building is constructed so that apertures are left for rodents to use. Thoughtless or ignorant methods of food storage, careless stacking, and general untidiness may allow a considerable infestation to become established in an otherwise sealed building into which a rat or mouse family has been introduced through the main entrance, in straw packing materials for example.

The major requirements for survival and family life in the rodent world are food and housing, and to deny either or both of these is a means of discouraging infestation. Therefore, material which is likely to be suitable for rat food, e.g. cereals, starchy vegetables, and fatty compounds including even tallow and soap, should be kept in rat-proof metal bins or containers, and refuse of the same type in properly covered metal dustbins whilst awaiting removal. Temporarily unemployed articles should not be allowed to accumulate in odd corners and remain undisturbed for more than a week or two, for they provide

a refuge for rats; anything under which rats may seek cover should be eliminated from the building and the yards attached to it.

Drains often provide an entrance to a building and should be maintained in good repair with all inlets, manholes and rodding eyes properly sealed or covered. Other vulnerable points are broken air-gratings in walls, openings for pipe-work, ill-fitting doors, worn

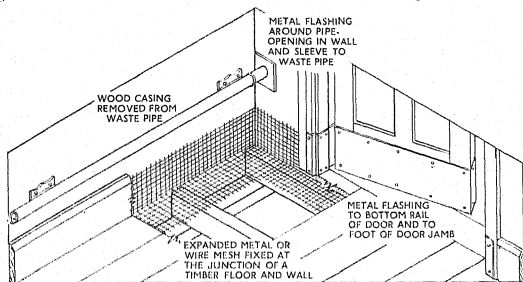


FIG. 39 Rat proofing: methods of protecting some vulnerable points

thresholds, the gnawed bottoms and jambs of doors, and corrugations in the wall or roof. Structural harbourage may occur below hollow floors, in hollow walls and partitions, in pipe ducts and casings, and less commonly in roof spaces.

Fig. 39 illustrates remedies for some of the common defects mentioned above, it shows some of the means by which the passage of rats from one part of the building to another, for example, from a sub-floor space and the room above, may be prevented.

It will be seen that to proof a building against rats, openings must be sealed by cement mortar, sheet metal or mesh. Similar materials should reinforce vulnerable points such as door edges and the meeting points of walls and floors.

### Habits of rats

A knowledge of rat habits provides a key to the method of extermination likely to be successful, and a few significant details are given.

1. A rat will traverse an open space only in an emergency and will tend to cling to cover on one side at least by keeping close to walls.

2. All rats acquire settled ways of travel from their abode to feeding places, so that well-defined paths are easily distinguishable as footprints or tail sweeps in dusty places, trodden earth, scrapings from burrows, gnawings, faeces, or smears from body-grease on surfaces rubbed by the rats as they pass.
3. Rats have an instinctive suspicion of the unaccustomed and for a time avoid new objects placed in their normal paths.
4. Both experimentally and in practice, rats and mice show a preference for cereals over all other kinds of bait and they are particularly fond of moistened cereals.
5. Primarily nocturnal in habit, an adult rat eats about three ounces of cereal bait during a night in quantities of perhaps one-fifth ounce every half-hour.

By making use of this information, poisoning campaigns can be planned with an expectation of a good percentage kill: 1 and 2 will indicate feeding points, 3 indicates the necessity of planting fresh unpoisoned bait night after night until as many as possible of the colony have become used to finding food at that point, usually three or four nights. The bait bases now generally employed are moistened sausage rusk, soaked wheat and bread mash. From 4 and 5 it is apparent that the concentration of poison in one-fifth of an ounce of cereal on the final night must be lethal, and, moreover, lethal before the next meal becomes due in about half-an-hour's time. This can be achieved with reasonable success by adding 2.5 per cent by weight of zinc phosphide to the bait or 10 per cent by weight of arsenious oxide, or 10 per cent by weight of red squill powder; this powder is harmless to domestic animals and humans.

Attempts for one week along the above lines may leave some survivors who were perhaps off feed on the critical night or sufficiently robust to withstand the treatment. These are likely to have developed prejudice against the bait and poison used. After a fortnight's interval, test baits differing from those first used should be put down and survivors coaxed by a repetition of the confidence trick used before.

Whilst there are numerous materials which are poisonous to rats, a few only are suitable for use with bait, using the method already mentioned. Because prejudice to bait and shyness to poison may develop in the survivors of a colony after treatment, a repetition of the campaign within three months needs a complete change of base poison.

The comparatively recent "Antu", which is said to be non-toxic to man is a useful alternative when the traditional mineral poisons have already been used; it should be used as a 2 per cent addition to a cereal sugar base.

A recent development is the use, in suitable bait—e.g. oatmeal, of a material known as "Warfarin" which has the effect, after several doses, of preventing the coagulation of blood and producing spontaneous haemorrhage. During the feeding period of three to eight days before death, the rat appears to experience no pain or significant loss of appetite and no bait-shyness develops. As the poisoned bait is acceptable immediately, no pre-baiting is carried out, but the poisoned bait must be replenished or renewed for a period up to ten days. The proportion of "Warfarin" used in the bait is so small (up to 0.025 per cent) that there is a large margin of safety in case of accidental ingestion by man or domestic animals; its quality of being effective only as a result of repeated doses makes danger to other creatures than rodents still more remote. It is, however, considered advisable to lay the baits in containers to which only rodents can readily gain access.

By luck and by guile rats may be trapped, but poisoning is generally more wholesale in effect when practised methodically.

### Mice

The mouse appears to be less a creature of habit than the rat, with less suspicion of unfamiliar objects and less consistency in travel routes and established feeding points. Thus the individual trap is effective while wholesale extermination by poison may be less effective than when it is used against rats.

Of all traps, the spring break-back type is as good as any other, although it suffers from the disadvantages that once sprung it is of no further use until reset. A good effect can be obtained when a substantial number of such traps are set in a mouse-infested area over a period of several nights. It is found that traps with a treadle or plate are better for holding bait than those with a prong for they allow the use of cereal bait, such as oatmeal, flour or breadcrumbs, which, contrary to popular belief, are more attractive to mice than the traditional cheese.

To clear a mouse infestation by poison, the bait used should consist of damped sausage rusk, rolled oats, or a mixture of nine parts national flour to one part of castor sugar (by weight). The poison may be zinc phosphide, or arsenic, mixed with the baits in the following proportions:

2. All rats acquire settled ways of travel from their abode to feeding places, so that well-defined paths are easily distinguishable as footprints or tail sweeps in dusty places, trodden earth, scrapings from burrows, gnawings, faeces, or smears from body-grease on surfaces rubbed by the rats as they pass.
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Zinc phosphide to sausage rusk	2.5	per cent
Zinc phosphide to rolled oats	2.5	per cent
Zinc phosphide to sugar meal	5	per cent
Arsenious oxide to sausage rusk	10	per cent
Arsenious oxide to rolled oats	10	per cent
Arsenious oxide to sugar meal	15	per cent

A large number of  $\frac{3}{4}$ -oz. plain baits should be laid on the first night and if the take is very good, poison bait may be laid the next night; if the take is poor the pre-baiting should be repeated for two or three nights before the poison is given. This treatment should be repeated to deal with survivors after an interval of fourteen days.

Fumigation may be used against both rats and mice in certain buildings or situations. Since hydrogen cyanide is the most suitable gas for this purpose and it is highly toxic to man, only specially trained operatives may be entrusted with this work.

### House flies

House flies, bluebottles and greenbottles, once so prevalent and potentially dangerous, are nowadays less numerous as a result of two major changes in our way of life over the past half-century. These changes are, firstly, the replacement of the horse by the internal combustion engine, and a consequent diminution in the amount of horse manure, which is the fly's first choice as a breeding ground; secondly, the water carriage system of drainage in use throughout urban areas which greatly reduces the risk of access by flies to infectious material.

In spite of these improvements there are often far too many flies about in their season, for any uncovered and undisturbed vegetable refuse, fish or meat offal can serve as alternative breeding grounds. The chance that a fly may carry communicable diseases to many by infecting food appears to be rather remote as a general rule, but it must not be overlooked that there are circumstances where a limited number of flies may gain access to infectious material; for example, in places where earth closets or pail closets are in use, in crèches and day nurseries where very young children are still at the "pot" stage, at slaughter-houses and knacker's yards, and in places where there are stools of rats, mice, cats and dogs, all of which may carry food-poisoning organisms.

Whilst the danger of fly-borne contamination of food must not be over-emphasized, and certainly not to the extent of diverting the public mind from the really vital safeguards of personal cleanliness and refrigeration, it would not be safe to ignore completely the

possibility, and steps should be taken to deny flies access to food intended for human consumption.

The control of flies is everyone's duty, but it is of special importance to the food-handler. Three methods of approach may be suggested, but since none of these can be expected to be completely effective independently, it seems that a combination of all should be practised. Control may be exercised (1) by the elimination of breeding places, (2) by measures to destroy the fly at some period of its existence, (3) by not exposing foodstuffs, or better still by screening food premises.

So far as the elimination of breeding places is concerned, it is the responsibility of the food trader to keep his own premises free, but others have a duty in the matter too. Refuse is universal and the public should be aware of the sources of fly-breeding material, so that they too may play a part in its control. Likewise the local authorities should be vigilant in detecting and dealing with accumulations of offensive material. With the present demand for the salvage of animal feeding stuffs, modern methods of refuse collection, and the availability of suitable refuse bins there is no reason why waste which is attractive to flies should be left putrefying and uncovered anywhere.

Measures against the fly, as with all pests, depend primarily for successful application on a knowledge of the life-cycle and habits of the insects. In common with many other species, the house fly passes through four stages in its life-cycle, the time spent in each part depending upon weather conditions, especially temperature. The stages are: (1) The egg which is laid by the female in some material which provides food for (2) the larva or maggot which hatches from the egg after eight hours to three days. The larva burrows into its food supply, eating vigorously until fully grown, which takes from forty-two hours to as much as six to eight weeks, when it seeks a dry and cool spot in which to pupate. The pupa (3) or chrysalis remains motionless in its cocoon until a period of three days to four weeks has passed when (4) the adult fly emerges.

It will be seen that the two most vulnerable states are the larval and the adult, when the creature is mobile. Migrating maggots should be destroyed by boiling water whenever observed, and where manure bins are used they should have a larva-trap either beneath or around them. Although there are many forms of fly trap and poison, the most effective method of fly destruction at present in use is the insecticidal spray containing pyrethrins and D.D.T. or Gammexane. Liberated as a fine mist, the spray can have an immediate killing



effect; or when sprayed in a higher concentration on walls, ceilings and hanging fixtures it will have a residual action, killing flies which come in contact with these surfaces over a period of weeks. Fixed electrical appliances providing continuous dispersal of vaporized D.D.T. have been found to be effective. But the deposition of D.D.T. on food or on equipment in direct contact with food must be avoided because of possible toxic effects.

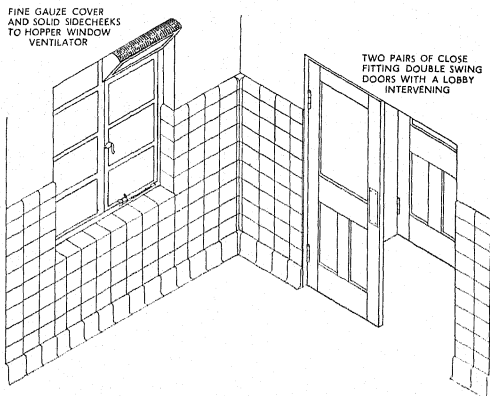


FIG. 40 Fly-proofing: protecting common places of entry

The fly-proofing of food premises is not always easy to secure, but as a minimum all doors should be self-closing and windows and ventilation openings covered with fine gauze. It is said that a net, which moves in the wind, may be hung loosely over doorways to exclude flies, for even though the mesh be quite large apparently the flies fear to be caught in it; old-fashioned screens of reed and beads serve the same purpose. In buildings which are not fully proofed against flies—and how many are not—larders at least must be safeguarded and displayed foods must be covered; crockery and cutlery should be equally protected after cleansing.

### Cockroaches

Cockroaches most common in this country are the oriental cockroach or black beetle and the German cockroach or steam-fly, which

is a light yellow-brown in colour. The two species are not commonly present in one building at the same time. They are both nocturnal in habit, occupy crevices in walls and floors, especially in warm places, and are catholic in their choice of foodstuffs, with a notable taste for beer. Hitherto they have rarely been implicated in outbreaks of disease; nevertheless, salmonella organisms were isolated from cockroaches infesting a children's ward in a hospital where there had been an extensive outbreak of gastro-enteritis.

Control measures include, first of all, the repair and stoppage of any places suspected of harbouring the insects. Sometimes it is best to open up enclosed hollow spaces such as covered pipes, ducts in walls, or spaces behind equipment; it may be necessary to re-site cooking appliances at a distance from walls, so that their backs are accessible for cleaning.

It is certain that these insects, like many others, are susceptible to a mixture of pyrethrins and D.D.T. or Gammexane, which may be administered as sprays or powders applied to the floors and skirtings at intervals of two or three weeks.

### Ants

Ants are not of any particular public health importance as far as is known, but they may be tiresome in kitchens and other food premises on account of their desire to share the food of the human race. Much can be done to avoid attracting ants, by the most careful observance of cleanliness; even the smallest crumbs of waste food must be removed, and cracks and crevices that may appear in walls and floors must be stopped up immediately. Two kinds of ant may enter buildings—garden ants which nest outside but enter in search of food, and house ants which settle in warm buildings. The best way to eliminate either type is to destroy the nest, and in the case of garden ants this can be found and treated with boiling water or paraffin. When infestations are established indoors, however, it is a different matter. A war of attrition against the worker-ants can sometimes starve out the queen but losses in the ranks are so quickly made good that it is a lengthy process and the daily kill must be heavy. The use of D.D.T. or Gammexane sprays or powders are reasonably effective if repeated at intervals of two to three weeks. A system by which worker-ants take back poisoned food to the nest has been successful in some cases, although it may take as long as two months before the elimination is complete. As a preliminary, baits of raw liver are laid and from these the ants will leave blood trails on their regular paths to the nest. Round wax cardboard bait boxes about 2 inches in diameter and

perforated to let ants in and out are then placed on the established foraging routes.

The bait base of bread, or better still, cake-crumbs, is mixed to a wet mash with the following syrup mixture which can be made up by a chemist.

Water	51	per cent
Sugar	42	per cent
Honey	6.5	per cent (by weight)
Thallium sulphate powder	0.5	per cent

This mixture is poisonous to man, hence the use of boxes to contain the material. To be attractive, the bait must be soft and moist and in the boxes described it will remain so for four or five days. The boxes should be labelled POISON.

### Wasps

Wasps can be a nuisance at times and seem to find their way into premises which would be regarded as fly-proof. A wasp's nest can be destroyed by thorough soaking with a D.D.T. and Pyrethrum spray. If it is in a safe position, it may be burnt. This work should be carried out at twilight when the wasps are all in the nest and sleepy. D.D.T. powder may be scattered at the entrance to inaccessible nests, when contaminated insects will carry D.D.T. into the nest; this, however, is a slow business.

## CHAPTER XIV

### FOOD TRADER'S PART

The number of food-poisoning incidents traced to retail shops is small compared with those reported from school, factory, and municipal canteens. One of the reasons for this apparently low proportion is that the number of home incidents is almost impossible to calculate, for so few family outbreaks are reported. The opportunities for investigation are, therefore, rare; when they do arise it is not always possible to find out whether the foodstuff was contaminated in the shop or in the home.

The food trader himself may not always realize that careless food handling occurs in his shop; those who come in to buy are often in a better position to notice the habits of those serving. There should be such a measure of co-operation and goodwill that criticisms and suggestions may be accepted on both sides of the counter. It is not implied that the shop staff are always at fault; the customer may also have careless habits which jeopardize the foodstuffs on show. Coughing and sneezing near uncovered foodstuffs should be discouraged. Cooked meats and cream cakes in particular should never be left in such a position that they may be touched. The disadvantage of allowing animals in food shops has already been discussed.

#### **The retail butcher**

In each of the three years 1949-51 more than 50 per cent of food-poisoning incidents were traced to contaminated meat dishes; and a salmonella outbreak occurred in 1947, already described on page 26, in which an infected pig's carcass was responsible for the contamination of corned beef in retail shops. The spread of contamination between carcass meat and cooked meat was greatly facilitated by the use of the same utensils, knives, and balances for the two types of meat, and salmonella organisms from the infected carcass were spread to other types of meat product sold in the shop. Dangerous germs should not be present in raw meat; nevertheless, most carcasses will carry a considerable load of a great variety of bacteria picked up in the slaughter-house, meat market, transport van, and in the retail shop. They should, therefore, be treated as a potential source of danger, particularly when canned meats sold loose and other prepared meats such as pressed beef, tongue and breakfast sausage,

which are not cooked before eating, are on sale in the same shop. The greater the load of bacteria given to cooked meats by those in the retail shop, the shorter will be their keeping time in the home and the greater the danger of bacterial food poisoning.

If possible, the retail sale of raw and cooked meat should be carried out separately, with an individual knife and balance pan for each, and with different members of the staff to handle them on separate counters. These conditions are easily established in a large shop but a smaller one may find it difficult to do so. Nevertheless, separate utensils could be used and they should be cleaned and sterilized frequently in boiling water. Cloths used for cleaning benches and for other purposes should be washed and boiled at least daily, the benches swabbed down at frequent intervals with a germicidal substance such as a hypochlorite solution, hands washed frequently, and overalls and other apparel should be scrupulously clean. Wash-hand basins with running hot and cold water, soap, and individual towels should be within easy reach of all those serving or in any way handling the food products, and there should be a source of heat (a gas ring would serve the purpose) for boiling supplies of water which can be used to sterilize utensils and cloths. The same rules for general cleanliness as those recommended in the chapters on kitchen design and equipment and utensil sterilization apply equally to retail shops.

The exposure of uncovered cooked meats at shop temperatures, either in the window or on the bench immediately beneath the faces of the queuing customers, is a potentially dangerous practice.

Open packs, that is, untinned cooked meats, usually leave the factory with a small load of bacteria. While they are exposed in the shop window or on the bench the bacteria will increase at a rate depending on the length of time that the foodstuff is left at atmospheric temperature; on warm summer days multiplication will be faster than in cold weather. All foodstuffs susceptible to bacterial growth such as these should be stored in the cold pending sale. An ideal solution to the problem is the refrigerated show-case which it is hoped will become increasingly popular and economically possible. It serves many purposes, the food is kept cold, it is displayed in an attractive manner and there is protection against flies. In some of these cabinets there are refrigerated shelves or drawers for storage below the display counter. These cold cabinets may be combined with "deep freeze" storage for frozen foods.

A great deal has already been said about the contamination of foodstuffs, particularly cooked meat, by the hands. Various metal gadgets to replace the hand for steadying blocks of pressed or corned beef,

breakfast sausage, and similar substances are used in the principal stores. One would like to see these utensils in more common use in small shops.

Perforated perspex covers and plastic plates and blocks which are easily cleaned and sterilized should be considered useful and essential parts of equipment for the shop which is selling cooked meatstuffs.



FIG. 41 Refrigerated showcase

### The retail fish shop

There are two recommendations for the fish shop—the closure of shop-fronts and the installation of refrigerated slabs and show cases (Fig. 41).

All open-fronted shops, whether used for the sale of fish or other type of food, are subject to many sources of contamination from the air, passers-by, animals and insects; furthermore, there seems no good reason why the smell of fish should so readily pervade the street. It is true that the closed shop must be well ventilated to prevent the same nuisance to employees. Most fish reach the shop already cleaned and beheaded; nevertheless, a small amount of gutting and filleting is inevitable and a separate room or compartment at the back of the shop should be provided for this purpose. It has been shown that fillets of fish, because they have been much handled, are far more likely to contain food-poisoning bacteria of human origin than whole fish.

There should be ample supplies of water and facilities for washing the hands, fish, and equipment.

It has already been noted (page 40) that food poisoning from freshly cooked fish is uncommon, but when pre-cooked or left-over fish is mixed with cooked potato, rice or other material for pies, rissoles, and kedgerree, food-poisoning germs may be introduced.

Cooked shell-fish are subject to the same hazards of handling, and cockles may be contaminated at many points after their heat-treatment in the cockle sheds and before they reach the consumer. Cockles for distribution to far distant places are heavily salted, those for local distribution are lightly salted only and, therefore, more susceptible to contamination.

### **The retail grocer's shop**

Much of the foodstuff on sale in the grocer's shop such as the tinned and packed goods, are safely protected from contamination. Fats such as lard, margarine and butter may serve as vehicles of infection for the organisms causing enteric illnesses and dysentery, that is, those food-borne diseases which follow infection by very small doses of germs; but fats are not vehicles of infection for food poisoning, because they do not encourage the proliferation of food-poisoning bacteria. Scrupulous cleanliness is, of course, as necessary in the grocer's shop as in any other food shop. The same precautions in the handling of cold meat and pies should be taken as recommended for the butcher (page 139).

### **The retail baker's shop**

The preparation and service of confectionery cream requires the greatest care and attention. Even though synthetic cream may reach the bakery from a large manufacturer in a state of bacterial cleanliness, there is ample opportunity for contamination of the cream by those in the bakery.

The cotton bag used to squeeze cream on to cakes and trifles is a source of danger, because it can contaminate succeeding batches of cream and through it the hands are in contact with the cream. A more satisfactory piece of equipment would be one constructed of metal which could be easily cleaned and sterilized; otherwise paper fillers should be used which can be discarded at the end of the session of work. If cotton bags must be used, then they should be thoroughly washed and boiled at frequent intervals. Plastic bags are now available but they cannot be boiled.

Outbreaks of food poisoning have been caused by the contamination

of synthetic cream mixed in a bowl previously used for some other contaminated product such as dried egg powder or ducks' egg contained in a cake mix. Such faulty methods can only be avoided by the constant vigilance and care of the staff. Synthetic cream left over from each day's supply should be either thrown out or refrigerated overnight, it should not be mixed with fresh batches of cream.

General cleanliness and scrupulous personal hygiene is as important for those engaged in bakery work as for those working in large kitchens, and yet it is often hard to convince bakers of the important part they play in the prevention of the spread of infection. The bakery trade is old and well established and it is hard to break the common practices of many hundreds of years.

Confectionery should be protected from airborne contamination, and wherever possible it should be handled with tongs and not with fingers. Bread is rarely a vehicle of food poisoning, and its wrapping is a matter of convenience rather than a necessary public health measure.

### **The retail dairy shop**

The responsibility for the hygiene of milk is largely the concern of those engaged in pasteurization and bottling. Many shops, in addition, handle ice-cream, and this product must be under the constant vigilance not only of the manufacturer but also of the public health authority.

As described on page 37, the last three years have shown a vast improvement in conditions for the production of ice-cream.



## LEGISLATION—PRESENT AND FUTURE

**Food and Drugs Act**

In 1938 the laws concerning hygiene in catering establishments were formulated in the Food and Drugs Act. Section 13 of this Act deals with premises in wide and general terms. It gives the provisions to be observed in relation to rooms in which "food intended for human consumption, other than milk, is prepared for sale or sold, or offered or exposed for sale, or deposited for the purpose of sale or of preparation for sale". Section 15 of the same Act authorizes local authorities in England and Wales to make "bye-laws for securing the observance of sanitary and cleanly conditions and practices in connection with the handling, wrapping and delivery of food sold or intended for sale for human consumption, and in connection with the sale or exposure for sale in the open air of food intended for human consumption". Section 14 deals with the registration of premises used for specified purposes in connection with the manufacture or sale of ice-cream, sausages, potted, pressed, pickled or preserved food intended for sale and is of limited application to the catering industry.

Section 9 makes it an offence for any person to sell or to deal in any way with a foodstuff offered for sale which is unfit for human consumption.

Section 10 authorizes the inspection and seizure by responsible officers of any foodstuff intended for human consumption which appears to be unsound.

Section 17 requires notification of food poisoning.

Section 77 grants the right of entry to authorized officers of local authorities.

Other sections are designed to prevent the danger to health from the importation, preparation, transport, storage, exposure for sale and delivery of food of various kinds, other than milk, intended for sale or sold for human consumption. The Milk and Dairies Regulations are included, while further sections, with which we are not particularly concerned, deal with the composition and quality of food offered for sale for human consumption.

Although they cover a wide field, the hygienic requirements laid down by the Food and Drugs Act are often vague and therefore

difficult to apply, and this lack of clear-cut information has retarded the enforcement of standards of hygiene.

With a view to preparing the way for more specific codes of practice for food establishments, Model Bye-laws were introduced by the Ministry of Food in 1949.

### **Model Bye-laws**

These bye-laws concern the handling, wrapping, delivery of food, and the sale of food in the open air. They are intended for adoption by local authorities, if the said local authority so desires; the Ministry of Food is the examining authority for any bye-laws made under Section 15 of the Food and Drugs Act.

The Model Bye-laws are divided into three parts. The first defines the terms used in the second and third parts; the second deals with bye-laws which apply to persons handling, wrapping or delivering food intended for sale for human consumption; the third deals with bye-laws which apply to persons selling or exposing for sale in the open air food intended for human consumption.

In the section which deals with the handling, wrapping and delivery of food there are six clauses concerned with the personal cleanliness of the food-handler and his clothing. It is stated that "no person knowingly suffering from or knowingly being a carrier of any disease shall handle, wrap or deliver any food so as to give rise to any risk of the spread of the disease". No specific details are given, however, of the types of disease or how the person is to know that he is suffering from them. All precautions must be taken "to protect food from dust, dirt, mud, filth, dirty water, animals, rodents, flies, insects, and other source of contamination including contamination by other persons"; this applies to all foodstuffs on sale in shops or in process of transit. All counters, slabs, fittings, apparatus, stoves and ranges, utensils, crockery and cutlery, and surfaces with which the food is in or liable to come in contact, must be kept clean, and the interior of every vehicle and every container from which the food is delivered must be kept clean. Refuse, whether solid or liquid, should not be deposited or allowed to accumulate in any room used for food work. These are excellent ways of obtaining hygienic conditions and everyone will agree that on the correct interpretation of them lies the production of clean food supplies. On the other hand the bye-laws give no constructive help on the means by which these recommendations should be carried out.

There is a section which deals with wrapping and containers used for foodstuffs, such as paper, fish boxes, ice-cream cans and biscuit tins.

Another deals with the disposal of refuse and the necessity for suitable lighting fixtures; and another with all surfaces with which the food is in or is liable to come into contact, including the interior of vehicles or containers, which should be of such materials and kept in such "good order, repair and condition as to prevent as far as is reasonably necessary the absorption of any food, material or refuse which may be spilled, splashed or deposited thereon or brought into contact therewith"; all such surfaces must be kept thoroughly clean.

Such conditions are a necessary foundation for good food hygiene but they are difficult to interpret because they lack specific practical details; nevertheless, they open the way for further instruction.

Similar recommendations are laid down for sale and exposure for sale in the open air of foodstuffs. In brief, these foods must be protected from all types of contamination. Stalls, utensils and other equipment must be kept clean and they must be constructed of such materials as can easily be kept clean; disposal of refuse must be carefully and conscientiously carried out. There must be sufficient lighting, and the name and address of the trader must be legibly and conspicuously displayed on the stall or container, which must be kept in a proper state of repair.

These Model Bye-laws, therefore, throw light on the points needing careful attention, but uniformity of administration is unlikely because their interpretation is open to wide variation.

### **Recent hygiene reports**

In 1948 the Ministry of Food set up two Working Parties and a Committee to explore conditions in the meat and catering trades with a view to improving food production and sale in the wholesale and retail trades.

Representatives chosen from commerce, industry, trade unions, various ministries, education establishments, and the Public Health Laboratory Service met regularly for discussions over a period of two or more years. Those educated in the principles of public health and hygiene debated with the industrialists and catering trade members concerned mainly with the economy of day-to-day practices.

The results of the deliberations are incorporated in three Reports to the Ministries of Food and Health and Secretary of State for Scotland. They are "Report of the Meat Products Working Party" (1950), "Report of the Interdepartmental Committee on Meat Inspection" (1951), and "Report of the Catering Trade Working Party on Hygiene in Catering Establishments" (1951).

It is worth while to consider the Codes of Practice recommended by the Catering Trade Working Party in some detail. Two codes were drawn up: the Standard Code, short, simple and containing the essential requirements only; and the Target Code giving the requirements considered necessary for the preparation and service of food in catering establishments under the best practical conditions.

It was suggested that the recommendations in the Standard Code should be regarded as the working requirements necessary for every catering establishment to which it applied. Failure to comply with any of its recommendations would result in appropriate action being taken by the local authority. Persistent disregard of its provisions could endanger public health, and therefore the action of the local authority in revoking the registration of such an establishment would be justified. Registration was considered by most members of the working party to be a necessary requisite for the institution of good conditions throughout the country.

For certain types of catering, such as in public-houses, from mobile vans, and from coffee stalls, special provisions were made, and it was agreed that it should be left to the local authority to decide whether or not a particular establishment fell within requirements of the Standard Code.

The Target Code, on the other hand, set out to provide a long-term policy of comprehensive requirements which the Working Party hoped to see carried out in most parts of the catering industry. The requirements of this code are printed at the end of the chapter (page 151). It is pointed out that the Target Code was so-called because it was considered impossible for every requirement to be carried out by all existing catering establishments; and for this reason the Working Party refrained from making a recommendation to render these provisions obligatory. It was felt, however, that a target of attainment should be set for all establishments.

As we are considering measures to produce healthier conditions of food cleanliness, the Target Code has been reproduced here rather than the Standard Code, in the hope that all food-handling members of catering and other establishments will aim at the higher standard.

Although considered by the Working Party to set too high a standard for general application, nevertheless for teaching purposes it may not be considered to go far enough. For instance, recommendations might be given for the minimum space required for kitchens and canteens, and more information could have been supplied on the

most suitable surfaces for walls, floors, ceilings, table-tops, draining-boards and sinks.

It is stated in the Report of the Catering Trade Working Party that, although it would be impracticable to advocate a system of medical examination for catering staffs either on engagement only or periodically, nevertheless fuller powers should be available to control carriers of food-poisoning organisms.

The employment of carriers of typhoid, paratyphoid and dysentery bacilli in food premises was forbidden by the Public Health (Infectious Diseases) Regulations, 1927. In 1953 these Regulations were revised and now the provisions against the risk of food poisoning apply to "typhoid fever, paratyphoid fever or other salmonella infections, dysentery and staphylococcal infections likely to cause food poisoning". It seems unavoidable, however, that in many instances such carriers will be discovered only after the occurrence of an outbreak for which they may have been inadvertently responsible. For example, although the employment of typhoid carriers as food-handlers is forbidden by law, those who carry typhoid bacilli are not always aware of the fact. The outbreak of typhoid fever which occurred in Aberystwyth in the summer of 1946, when there were hundreds of cases and many deaths, was caused by the contamination of ice-cream by a manufacturer who had been ill with typhoid in 1938. There had been no bacteriological follow-up of stool or urine samples, and therefore the fact that he was a carrier was unknown to anyone, and least of all to himself. Another instance of the harm that can be done by a carrier of typhoid bacilli is illustrated by the well-known history of "Typhoid Mary". Mary was an American cook. In one after another of the houses where she worked cases of typhoid fever occurred, some of them fatal. When her infective condition was discovered she was detained in hospital. Mary was dissatisfied, however, for she did not believe the true explanation of the typhoid fever that followed her. So she ran away to cook again in other households and inevitably further cases occurred. Again Mary was found to be the cause of the trouble, excreting large numbers of typhoid bacilli in her stools; and for the rest of her life she retired to an island.

In an attempt to limit the number of such epidemics, in this and certain other countries records are kept of all the known typhoid carriers. Their changes of address must be notified, and they are, of course, forbidden to take up any occupation connected with food. It has been estimated that 2 to 3 per cent of those who have suffered from typhoid fever retain the organisms for an indefinite period.

### Food hygiene at fairs

Although not strictly concerned with legislation of the present or near future, it may be of interest to describe here the improvements carried out in recent years to the food arrangements of a well-known fair ground. They illustrate the powers which may be exerted by public health authorities and indicate a plan for future legislative action to improve the hygiene of fairs.

In the old days, food stalls selling ice-cream, shell-fish (cockles, mussels, shrimps, scallops and winkles), fish and chips, candyfloss, together with mobile snack bars selling soft drinks, tea, sandwiches (meat, egg, and fish), rolls and cakes, were scattered indiscriminately among the amusement stalls. An ice-cream cart stood between a shooting booth and the electric "dodgems", and cockle stalls were everywhere. Much of the food was exposed to the air which was heavily laden with the dust raised from a loose soil and gravel ground surface; dust and dirt could be seen plainly on the surface of the foods, which were exposed also to droplets from the coughs and sneezes of the loitering crowds.

Washing facilities were almost non-existent, sanitary conveniences were primitive and few and far between. Some of the food vendors brought drums of water; otherwise they had to walk a considerable distance to find a public water tap.

The first step taken by officers of the local authority concerned to improve these conditions was the concentration of all the food stalls in one area a little apart from the fair ground itself; a grass surface was chosen rather than gravel to eliminate some of the airborne dust contamination. The land was divided into plots to be let to the highest bidder by the Licensing Authority. Usually the same vendors return year after year, so that a check may be kept on the cleanliness of their foodstuffs and methods. It would be preferable, however, to institute a priced rental for each plot of land, and to let it after consideration by the Public Health Department of the applicant's hygienic capabilities. The competition for plots should be judged by the safety and cleanliness of the vendor's food products, not only at the point of sale but also during its preparation at the home premises, rather than by the highest bid. The Licensing Authority should be responsible for the conditions of the food on arrival.

The fair extends the length of a mile, and formerly there were three taps of mains water available for the whole of this area; alternative supplies which were used were undoubtedly the ponds and horse troughs. There was an urgent necessity, therefore, to provide water

within easy reach of each stall so that no excuse could be offered for failure to wash the hands or to provide water for cleaning equipment. Supplementary water pipes were laid along the area covered by these stalls, and stand pipes were erected so that no stall was separated by more than 10 to 15 yards from a water tap. Drinking fountains of the jet type were installed.

Drainage was provided for liquid waste, and for each food stall compound a dozen or more bins were installed for solid food waste.

In the early morning of each Bank Holiday, sanitary inspectors visit the fair, inspect each stall and collect specimens for chemical and bacteriological examination. Ice-cream, shell-fish, sandwiches and wash waters are examined in this way.

The stallholder who by observation and laboratory results does not appear to be fulfilling his obligations with regard to personal and food hygiene is approached and, after discussion, suggestions are made for improvements. In general there is no ill feeling and a friendly relationship can be established which is invaluable to both the food inspector and the vendor, who is often pleased that someone is taking an interest in him, and who is usually anxious to carry out suggestions for improvement.

Within a year or two of the institution of this supervision there was a noticeable improvement in the standard of hygiene. Nowadays one may expect to see cylinders of Calor gas used to improvise a supply of hot water both for personal and for equipment washing. Paper cups are frequently seen as well as straws for drinking soft drinks. Bactericidal detergents are in use for wash waters, and laboratory examination of samples of these waters shows that they are unusually free from intestinal bacteria of the coliform group.

The more modern types of mobile van are present where fish and chips and ice-cream are sold from stainless steel counters which are spotlessly clean, and there are glass cabinets on mobile snack bars, for sandwiches, rolls and cakes. In general, the bacteriological results are good. If bad results are continually obtained from any one vendor, then he is followed up to his own area with the help of the local authority concerned; although, at present, there is no power to exclude those vendors who cannot or will not maintain a satisfactory standard.

## THE TARGET CODE\*

**(A) The Working Premises**

1. The whole of the premises and fixtures should be so constructed and fitted that all parts of both premises and fixtures are capable of being readily cleansed.
2. Premises. The premises should be large enough for an orderly sequence of work without undue crossing of traffic lines.
3. Cooking Equipment. The cooking equipment should be so sited that wall areas adjacent thereto, and the equipment itself, are readily accessible for cleansing.
4. Floors. The floors should be free from cracks, without open joints, impervious, non-slip and capable of being easily washed down. They should slope evenly towards the drainage outlet.
5. Walls. The walls should be substantial, durable, smooth, impervious, washable and of a light colour.
6. Ceilings. The ceilings should be dust-proof and free from cracks.
7. Repair. All premises should be maintained in sound repair and every precaution taken against infestation from vermin.
8. Drainage. Gullies outside and in close proximity should be trapped. All yards should have impervious and even surfaces and should be properly drained.
9. Water Supply. An adequate supply of wholesome water piped to taps over sinks, lavatory basins and other appropriate fixed receptacles should be provided.
10. Hot Water. Apparatus to provide hot water up to at least 170° F. for all requisite purposes should be installed.
11. Lighting. All parts of the premises used for food preparation should be adequately lit, preferably both by natural light and by artificial light.
12. Ventilation. Adequate ventilation should be provided. Where a system of artificial ventilation is not installed an adequate flow of fresh air should be maintained.
13. Cloakrooms. Clean and adequate cloakroom accommodation should be provided for the staff distinct from but preferably adjacent to the food-preparation rooms.
14. Sanitary Conveniences. There should be a sufficient number of sanitary conveniences to meet the needs of the staff. Each convenience should have an adequate supply of toilet paper, and should be well lit, ventilated and kept clean.
15. Washing Facilities. There should be a sufficient number of wash-basins

\* Hygiene in Catering Establishments. Report of the Catering Trade Working Party, 1951, page 17.



in immediate proximity to the sanitary conveniences, and elsewhere as may be necessary to meet the needs of the staff. In addition a wash-basin should be fixed in the kitchen itself, or immediately adjacent thereto. (Kitchen sinks should not be used for hand washing.) All wash-basins should be well lit, with hot and cold water laid on, and should be kept clean. Soap, nail brushes and towels (for non-commot use) should be provided. (An efficient air drier is a satisfactory substitute for towels.)

### (B) Equipment

1. Adequate and suitable covered receptacles of impervious material for refuse, food scraps and the like with a suitable and sufficient storage place for them should be provided outside all food-preparation rooms.
2. There should be proper receptacles constructed of impervious material for all foods broken down from bulk. All except those for vegetables should have covers.
3. There should be a cool larder of adequate size for the storage of foods, particularly those of a perishable nature.
4. The surfaces of tables and benches should be impervious to liquids and without open cracks.
5. There should be separate and adequate storage for all utensils and, in particular, covered racks for crockery, trays for cutlery and suitable shelving for saucepans and small cooking vessels.
6. There should be a separate sink or sinks for vegetable preparation.
7. Ventilated hoods, or adequate alternative means for the removal of steam, fumes, intense heat from grillers, etc., should be provided wherever required.
8. Adequate equipment for cleansing and sterilizing utensils should be provided. Where a dish-washing machine is installed it should be worked efficiently and provide for the thorough cleansing of utensils and for their sterilization.\* For hand washing of utensils the minimal provision should be:
  - (a) a sink or sinks (according to the size of the establishment) for the washing of utensils, with hot and cold water laid on;
  - (b) a separate sink or sinks for sterilizing, each furnished with its own supply of water which can be kept at a temperature of not less than 170° F., by steam injection or otherwise, with automatic devices for recording temperature; sterilization in a steam chest if adequately carried out may be accepted as an alternative. In a small establishment a two-compartment sink for washing and sterilizing respectively may be used instead of two separate sinks, provided that the necessary device is available for recording the

\* The word "sterilization" throughout the Code is not used in the strict bacteriological sense of complete freedom from all living bacteria and spores, but as meaning freedom from harmful bacteria in an active form.

temperature; or sterilization can be effected by simple steaming in a suitable vessel;

- (c) metal racks with handles to hold utensils for immersion in the sterilizing sink.
- 9. There should be adequate shelves, hooks or racks, to receive utensils for air drying.
- 10. There should be reserves of glass, crockery and cutlery to ensure:
  - (a) the prompt replacement of chipped, cracked or bent equipment;
  - (b) that during rush hours there is no need to use inadequately sterilized equipment.
- 11. A sufficient supply of overalls of light colour, caps, "rubbers" and other personal equipment should be provided.
- 12. Where large containers are used for conveying meals (as in central kitchens for schools) a steam jet (or jets) should be provided with steam available under adequate pressure. The lids as well as the containers need to be sterilized. An adequate time of steaming is essential, and a clock with a large minute hand should be provided adjacent to the steam jet. Adequate sterilization in steam chests or in tanks containing boiling water may be accepted as a substitute in special cases.
- 13. There should be a reliable refrigerator or cold room of size adequate for the establishment provided with an easily visible means of recording the inside temperature. (A cold room is one which is capable of maintaining food at a temperature not above 40° F.)
- 14. Wrappings or covers or protective glass screens for food on display should be provided.
- 15. First-aid equipment should be available on the premises.

### (C) Management Requirements

- 1. The management should assign to a designated individual responsibility for checking the condition of all food delivered to the establishment and for taking action if it is considered unsatisfactory.
- 2. Perishable articles (milk, meat, etc.) should be kept in the larder adequately covered, or in the refrigerator or cold room, until required for use.
- 3. Manual handling of food should be avoided, so far as practicable.
- 4. Smoking while preparing or serving food should be prohibited.
- 5. Animals should be excluded from rooms where food is being prepared. At no time should animals have access to the food in the establishment.
- 6. Nothing should be stored on the premises which is not directly concerned with the work of the establishment.
- 7. All cooking vessels and other equipment should be maintained in a state of thorough cleanliness and repair and all smaller utensils (saucepans, etc.) kept in their proper places when not in use. Particular

care should be taken to maintain the linings of copper cooking utensils in such condition as to prevent direct contact between food-stuffs and the copper.

8. Premises should be maintained at a high standard of cleanliness. This involves washing floors at least once a day, supplemented by sweeping, using damping agents, as often as may be necessary and cleaning all walls and other surfaces at least once a week. All cupboards, drawers and other fixtures should be kept scrupulously clean and free from all articles other than those for which they are intended.
9. A high standard of personal cleanliness on the part of the staff should be maintained. Overalls and other personal equipment should be washed and changed sufficiently frequently. Waiters should preferably wear washable jackets.
10. A notice pointing out the importance of washing the hands after use of the sanitary convenience should be kept affixed in a prominent place in every convenience.
11. So far as practicable all food preparation should be done the same day as the food is consumed. When this is not practicable all partially prepared food should be stored *immediately* after preparation in the refrigerator or cold room and not removed until required to complete final preparations. The only exception is that of a hot food of large bulk (such as a joint), which should be allowed to cool down in a clean place before being placed in the refrigerator or cold room. Rapid cooling of foods in bulk is so important that suitable methods to ensure it should be employed, such as division into smaller portions and cooling in a current of air provided by a fan.
12. So far as practicable, left-over food should not be used again but, if it is to be used, it should be stored promptly in the refrigerator or cold room.
13. Made-up and other prepared foods should always be stored in the refrigerator or cold room without delay after preparation. To keep them at room temperature is dangerous.
14. When food is stored in the refrigerator it should be placed so as to allow air circulation. Meat joints are preferably hung from hooks. The refrigerator should be kept clean and thoroughly cleaned out on the occasion of each defrosting.
15. Detergents used in connection with utensil cleansing should be suitable for the conditions existing, and should be used in correct strength. The local authority should be consulted as to the appropriate detergents to use.
16. *Vermin and Flies.*  
Rats and Mice. Infestation by rats and mice is dangerous as they can spread infection to man. All practicable steps should be taken to eliminate this source of infection. It is essential:
  - (a) to maintain the premises in thorough repair and to stop all ascertainable means of rodent access;

- (b) to ensure that all food scraps are promptly removed and the premises maintained at a high level of cleanliness;
- (c) to provide impervious receptacles with tightly fitting covers for the storage of all foods attractive to rodents;
- (d) to consult and seek the help of the local authority if rats or mice are found in substantial numbers.

Flies, Cockroaches and other Insects. The number of flies on the premises can be materially reduced by the rapid and efficient disposal of all food scraps and by using fly-proof covers for food to the fullest possible extent. Manure or refuse piles or other materials serving for fly breeding near to the catering establishment should be reported to the local authority. The presence of cockroaches and other insects in numbers is often evidence of faulty fixing of plant and of inadequate hygienic practices. Thorough cleanliness and the provision of proper food containers are important preventive measures. The local authority should be consulted if the presence of these pests continues. When insecticides are used great care should be taken to prevent the contamination of food, equipment and utensils.\*

17. Measures to limit the infection of food from food-handlers.

- (a) No person who is suffering from a discharging wound, sores on hands or arms, discharging ears or who is suffering from attacks of diarrhoea or vomiting should take part in the handling, preparation or serving of food in any catering establishment.
- (b) Members of the staff should report to the proprietor or manager if they are suffering from any of the conditions specified in (a) above, or from any other illness.
- (c) The proprietor (or manager) of a catering establishment should take reasonable steps to become aware of the existence amongst his staff of any of the conditions specified in (a) above or of any other illness.
- (d) The proprietor (or manager) of a catering establishment, as soon as he becomes aware that any member of his staff is suffering from any of the above specified conditions, should not permit such person to handle food until he (or she) is no longer suffering from the condition in question, or permission has been given by the Medical Officer of Health.
- (e) In the case of the other illnesses, if there is a doubt whether the employee should continue to work, the employee should be referred to his (or her) doctor pending resumption of work.
- (f) Every applicant for employment should be informed of the possible risk from previous attacks of typhoid fever or paratyphoid fever and should be asked if he (or she) has previously suffered from one of these diseases. If he (or she) has so suffered,

\* No recommendation is made in this Report on the detailed use of insecticides since no finality as to the best methods has yet been reached.

particulars should be reported to the Medical Officer of Health and the applicant not engaged until approval has been given by the Medical Officer of Health.

18. Adherence to the hygienic requirements in this Code alone is not enough. It is of prime importance that all members of the staff (management and workers) should be imbued with and continually practise the principles of sound personal hygiene and that they should take full advantage of any suitable courses of instruction which are available.

## CHAPTER XVI

### EDUCATION

The place of education in the improvement of food hygiene in the catering industry is well reviewed by the Catering Trade Working Party in their Report on "Hygiene in Catering Establishments".

To improve the hygiene of food-handling there are two main requisites. First, the strict attention to personal hygiene of all those engaged in food-handling, and, second, the provision of suitable accommodation, including cold storage and equipment, by those in authority. Widespread and persistent instruction and persuasion are needed to implant these ideals in the minds of responsible people.

Kitchens and shops of a hundred or more years ago were designed by those who had no practical knowledge of the ways in which infection spread, and nobody knew the real cause of food poisoning and other infectious diseases. Many of the risks from food infection which occur today are still due to technical ignorance, an absence of knowledge of the importance of hygienic practices, and of the knowledge or importance of correct design of establishments and equipment to assist in the carrying out of these practices.

It is to be hoped that along with the growth of knowledge about the spread of infection will come a reasonable understanding by those who have to apply this knowledge. The necessary instructions should be given, therefore, not only for the technical education of managers and other supervisors, but also to all employees.

Children also should be given knowledge of the ways of spread of infection, so that good habits of personal hygiene will be natural to them in future years of food-handling.

#### Schools

Hygienic habits are not instinctive and the instruction necessary for their acquisition may not always be given in the home; the responsibility, therefore, falls partly on the school. In those schools teaching domestic science as a routine part of the curriculum, elementary bacteriology and its application to the prevention of food contamination can be conveniently taught and demonstrated practically during cooking lessons. Useful supplementary education can be given to schools by the local public health departments; this is already carried out in some boroughs by the sanitary inspectors. Practical

demonstrations on the growth of bacteria from the hands, nose, throat, and bowel, should be an essential part of any lecture demonstration.

Where there are food hygiene exhibitions, parties of school children should be taken round the various exhibits with an explanatory running commentary.

One public health department during a recent exhibition ran a competition for schools in the neighbourhood. This competition involved the composition of a picture displaying some particular lesson on the hygienic handling of food. The winning pictures were displayed at the exhibition. Many showed a remarkably high standard, and the interest aroused during their production must have been widespread, not only amongst school friends of the entrant but in home circles. Other competitions have had equally satisfactory results.

### **Kitchen staff and food traders**

There are two ways to establish contact with those who are at work in the kitchens of restaurants, hotels, canteens and food shops. These methods can be used separately or better still in conjunction with each other. The first is to gather together the managers, supervisors and other key personnel, and to give them a course of instruction in three or four talks spaced at weekly or shorter intervals. If a fairly full set of lecture notes is provided they can be used not only for future reference but also to compile suitable literature for distribution to other members of the staff or for the preparation of lecture notes for similar talks.

In large catering establishments and multiple stores this method can be used quite satisfactorily within the shop or store. When a number of school kitchens are concerned it may be necessary to arrange a meeting at one particular centre, under the control of the local authority. To attract the owners and assistants of small establishments including shops, cafés, snack bars, and portable food vans, public lectures and exhibitions may be given with the provision of lecture demonstrations and films; discussions should be encouraged.

The second method, to go out to people rather than to summon them to a centre, may be accomplished fairly readily in large establishments by the resident medical officer taking demonstration material to the various departments and talking to small groups of staff within the kitchen or shop. For small establishments it will be necessary for sanitary inspectors or other specially trained people to carry

out the same method. In any case the public talk and exhibition should be followed up by visits and further discussions.

The Catering Trade Working Party was of the opinion "that no large scale and lasting improvement in the hygienic conditions of catering establishments can be brought about unless informed public opinion demanded it. We would stress the word 'informed' because many people, while appreciating generally the value of cleanliness, have little knowledge of the real risks attendant on particular faulty practices. The dissemination of knowledge of the principles underlying food hygiene, should, therefore, be carried out by all practical means."

Most people can be reached by means of newspapers, pamphlets, exhibitions and public talks; while films, broadcasts and television programmes are widespread in their appeal. Newspaper reports of outbreaks should include carefully sponsored notes on the reason for the outbreak and the method of spread of infection.

The institutional magazines of large firms, the magazines and journals of associations such as the *Catering Trade*, *Hotel Management*, as well as general magazines, and in particular those specializing in domestic subjects, provide many opportunities for educative work.

The Women's Institutes also provide a wide field for talks and discussions on a variety of subjects relating to food and hygiene.

### **The provision of information**

Information on the hygiene of food-handling is available from many sources.

Medical officers of health, sanitary inspectors, and health committees of local authorities are carrying out educative work in this field. Much of the work is the responsibility of the sanitary inspector, whose contact with food traders, restaurant and canteen supervisors and others in his area enables him to ensure that the principles of hygiene put forward in talks and exhibitions are carried out in practice. On his constant vigilance depends the success of the drive to establish and maintain better conditions and technique amongst food-handlers which will indirectly cut down the incidence of food poisoning.

Education within the catering trade is being developed by the Hotel and Catering Institute; syllabuses and courses include instruction on the subjects of personal hygiene and food-handling. The City and Guilds of London Institute also include education on hygiene in their syllabuses and a further development of such courses is under consideration.

In 1947 the "British Tourists and Holiday Board" (now merged



with the "British Holiday and Travel Association") was set up. During 1948 and 1949 the catering division distributed posters and aluminium plaques emphasizing the necessity for hygienic conditions and practices to approximately 184,000 catering establishments.

The principal Ministries including the Ministry of Health, the Ministry of Food, Food Hygiene Division, the Ministry of Agriculture and Fisheries, Infestation Division, the Ministry of Education,



FIG. 42 Display unit for Food Hygiene Exhibition

and the Ministry of Labour and National Service are all concerned directly or indirectly with the hygiene of food-handling in the control of food-borne disease, and advice and display material are available from them. Independent organizations such as the Central Council for Health Education, and the Public Health Laboratory Service are active in the field of food hygiene education, while the King Edward Memorial Fund has recently set up a School for Hospital Catering at St. Pancras Hospital. Lectures, demonstrations, discussions, and films are given in yearly as well as in ten-day courses for all ranks of hospital catering staffs and cover all subjects relating to food organization, diet, preparation and service.

The Industrial Welfare Society is encouraging hygienic measures in factory canteens, the Central Office of Information has made films with the co-operation of technical specialists, and the larger catering

firms have carried the teaching and practice of hygiene far afield. Many commercial firms engaged in the manufacture of foods, equipment and detergents willingly provide exhibits for educational purposes.

Summer Schools, week-end and other refresher courses serve a useful purpose for teachers, school and hospital canteen supervisors and similar food organizers.

### **Clean food guilds**

Another activity in which the local authorities have taken a large part in the search for methods to teach the public and food traders the meaning of food hygiene, is the development of Food Traders Clean Food Guilds. The first experiment of this kind took place at Guildford, and other towns and boroughs have started similar guilds along the same lines. There are various methods of running these organizations, but the most usual appears to be the institution of a code of instruction for food traders and food-handlers, and the compulsory attendance at a series of lectures on subjects of food and kitchen hygiene. At the end of such a course of instruction, those who have attended regularly are issued with certificates; in one or two instances simple examinations have been held. When the hygienic arrangements and methods employed in a catering establishment or other food shop comply with the recommendations laid down in the codes of practice, and when each member of the staff has been issued with a certificate for attendance at the lectures, then a certificate of merit is awarded to the establishment. It has been suggested that a grading system should be introduced on much the same lines as that in the United States, when establishments would be awarded different certificates according to their stage of improvement. It is considered, however, that this method is open to discrepancies in the overlapping of grades and that it would be likely to fall into disrepute, whereas the granting of a single certificate to those who have reached a certain standard of hygiene is practicable and easy to carry out. One advantage of voluntarily accepted codes of practice is that statements of a statutory nature may be given practical expression; for example, the means by which the cleanliness of utensils, as required by the Act, is to be secured; by the use, let us say, of a sterilizing rinse in water at 180°F. after the utensils have been washed.

The Clean Food Guild, as well as encouraging keen competition amongst food traders and members of catering establishments, provides opportunities for social meetings when informal talks and discussions on the subject of food hygiene can be held. The scheme

should lead to a feeling of goodwill and unity between those intimately engaged in food-handling and the officers of public health departments, so that a united effort may be made to apply better standards.

The chief criticism against the guild system is that those who are given a certificate of merit may not always maintain their high standard and that a fall from grace may not necessarily result in the confiscation of their certificates. It is the duty of the local authority officers to see that this state of affairs does not occur; in fact the whole scheme is dependent upon the constant watchfulness of local authority health officers.

### **Aids to teaching food hygiene**

Semi-technical lectures to non-technical audiences are best illustrated with the aid of visual demonstrations, of which two or more methods can be used. Film-strips may be shown and accompanied by a running commentary; a large multiple store engaged in extensive educative work amongst its food-handling employees makes use of a film-strip together with the recorded voice of the commentator. A combined unit has been devised containing film-strip, projector and gramophone recorder, so that film-strips and sound discs can be sent around the country and used when no experienced lecturer on the subject is available.

Films illustrate in a lifelike manner points which are unconvincing by the spoken word. They should be preceded by an explanatory talk on the presence of food-poisoning germs in the normal human and animal body, the habits by which these germs may be transferred to foodstuffs, and the conditions under which they multiply.

Such a preparatory talk enables the audience to appreciate fully the faults illustrated in the film. "Another case of food-poisoning" is a film admirably suited for such teaching. It was produced by the Central Office of Information and sponsored by the Ministry of Health in collaboration with the Central Council for Health Education, the Ministry of Food, and the British Tourist and Holiday Board. There is a need for more films of the same order; the illustration of particular food-poisoning outbreaks would provide convincing evidence of methods of food contamination.

Illustrations in the form of charts, diagrams, posters and photographs may be usefully displayed in a lecture room for the interest of those arriving early, or for those who are prepared to linger after the talk. Charts and posters vary considerably in their design. Some may give structural information, for example, graphs which show the

rise in incidence of food poisoning in England and Wales during the current years, or which illustrate the critical temperatures of storage for foods and the rate of multiplication of bacteria in meat or egg products under different conditions of temperature. Others may indicate, in a simple diagrammatic form, the reservoirs of infection and the way in which infection is spread. Even more useful perhaps are those which endeavour to tell in simple pictorial form the stories of actual outbreaks of food poisoning. Picture stories in colour with simple explanatory headings have been found to be extremely popular both for use in lecture demonstrations and for exhibitions; they can be made into lantern slides also. Examples of these story charts are given in Chapter VI. Pictorial studies of the "do's" and "don'ts" of personal hygiene and kitchen hygiene are also useful aids to learning. A poster may serve to illustrate a single truth in a straightforward serious manner, or it may be designed in a humorous way by a famous cartoonist such as Fougasse.

Mounted photographs can illustrate the right and wrong ways to carry out various practices involved in the handling of food, the washing of crockery and cutlery, the bandaging of fingers and so on. Other photographs may show good designs for kitchens, with close-up views of the structure of walls, ceilings, floors and equipment, washing-up procedures, machines, and sterilizing tanks or simple sinks. The cleaning of floors, cleaning of dustbins, methods of storage, refrigerator space, susceptible foodstuffs, and personal hygiene can be illustrated in many ways by photographs, which should be of a convenient size and mounted on stiff card; they may be issued singly or in series illustrating a certain sequence of events.

Bacterial cultures on nutrient agar may be shown on an illuminated viewing box (Fig. 43). These plate cultures can include bacterial colonies grown from fingers rubbed on the surface of agar media; (a) from a moderately dirty hand which has not been washed for some hours; (b) from the hand of one who recently visited the toilet and failed to wash afterwards—to demonstrate the ease with which intestinal bacteria can pass through toilet paper; and (c) from a well-washed hand showing a few colonies of harmless bacteria only. Comparative culture plates show the effect of shaking clean and dirty handkerchiefs over the surface of agar media. Another plate may show the bacterial colonies which grow as a sheath throughout the length of a supposedly clean hair placed on the surface of agar medium. Cultures of clean and dirty drying cloths demonstrate the enormous numbers of bacteria present in drying cloths used for wiping crockery and cutlery taken straight from washing-up water. A fly running over the surface

of an agar medium may leave bacteria in the prints of its pads. The imprint of a fork, spoon or knife on a culture medium may produce a striking picture of colonies of bacteria grown from the imperfectly washed utensil. In addition, pure cultures of food-poisoning bacteria may be shown, for example, salmonella and staphylococci. There has

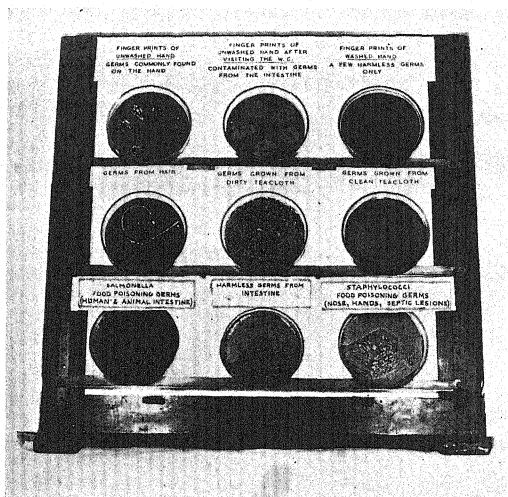


FIG. 43 Viewing box and display of bacterial culture plates

been a tremendous demand for plates of this type to illustrate, in a practical way, the facts that have been expressed in a lecture.

When a series of lectures is given to a small group it is sometimes possible to carry out experiments with volunteers from the class. Swabs from nose, throat, hand, fingers, and hair may be cultured; and the results shown at the next lecture, which must be held preferably not more than a week later; the volunteers are always keenly interested, particularly in the significance of their personal bacteria. Petri dishes containing culture media may be exposed in various parts of the room during the course of a lecture to demonstrate, roughly, the

number of dust and droplet particles containing bacteria which fall on to the plates in a short space of time; the plates are incubated and shown at the next lecture. Other experiments may be used to drive home particular points. The spread of infection may be demonstrated by coating the handle and lid of some utensil such as a saucepan with vaseline or other sticky material containing red dye. A member of the class is asked to grasp the handle of the lid, then to

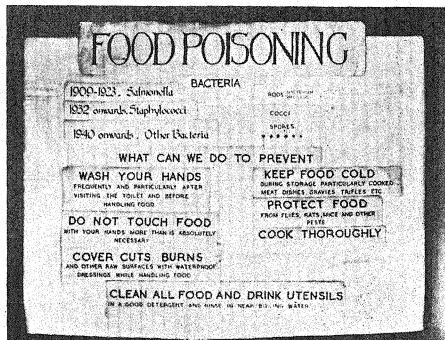


FIG. 44 Flannelgraph method of teaching

pick up one or two other utensils, walk in and out of the room turning the door handle with the contaminated hand, turn a tap, wash the hands, turn off the tap, and wipe the hands. After all this the lecturer can go around with a piece of white cotton wool rubbing the surfaces which have been touched by the volunteer; the red dye is easily seen on cotton wool and also on the towel used after retouching the "contaminated" tap. This experiment demonstrates the ease with which bacterial contamination from the fingers may be spread to many common objects, to be picked up later by other people whose hands will in turn become contaminated. Swabs may also be taken from plates, cups, spoons, forks, table-tops, floor, ration books, paper money, and any other things which members of the class may suggest.

Another visual aid, and one which is becoming increasingly popular, is the flannelgraph. Headings of lectures, facts to be stressed, pictorial diagrams, and coloured sketches can be most conveniently displayed by this method and, once prepared, the headings and

diagrams can be kept and re-used over and over again. A flannel-graph board may be improvised with a large piece of flannel, felt or lint pinned on to a blackboard. Alternatively a suitable piece of ply-wood can be covered with flannel, felt or lint; it is light and can be carried easily from place to place. Printed headings, diagrams and pictures done on moderately stiff paper are backed with flannel or lint, either by sticking the material over the whole of the back area of the cut-out or as small strips or discs. Flannel or lint adhere to each other and it only remains to place the headings and pictures on the covered wood or blackboard. The method is effective and simple and saves the time and effort of writing on a blackboard.

In a similar method small magnets are stuck to the back of the printed and drawn material and a special type of metal sheet, instead of the covered blackboard or ply-wood, is used.

It is possible, during a lecture, to use the flannelgraph, lantern slides, and also to have somewhere in the hall the illuminated viewing box with the culture plates and charts, diagrams and photographs so that there is something for the class or audience to study and learn in addition to the words of the lecturer.

Successful Food Hygiene evenings with a lecture demonstration and a small amount of exhibition material have been held in the dining-room of a school canteen, while the kitchen alongside is used for the demonstration of washing-up methods and the storage of crockery and utensils. Such evenings encourage a friendly spirit and much discussion.

While science seeks to explore more deeply the causes of bacterial food poisoning the public need to be given the facts so that all can play a part in breaking the chain of infection which leads from one outbreak to another. Education on the subject of food poisoning and its prevention is, therefore, essential and it should be made interesting and colourful by every means at the teacher's disposal.

The decline in the incidence of food poisoning will depend on voluntary as well as compulsory application of common-sense rules of hygiene in relation to food-handling.

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